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EDITED BY

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On the Formation of Nodules in the Cortex of *Hevea brasiliensis* Muell.-Arg.

BY

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WITH the development of the rubber industry and the planting of large areas in the Eastern Tropics under *Hevea brasiliensis*, a striking pathological condition of the cortex was brought to light. In the cortex of certain trees small woody bodies of varying shape and size were found; these bodies were termed "burrs" or "nodules." As the rubber plantations became older and the trees bigger in girth, tapping operations to obtain the latex from the cortex were begun. These burrs or nodules, which were considered to be comparatively rare in untapped trees, now appeared to occur more frequently in trees where tapping had been in progress for some time. However, other circumstances might combine to render their occurrence apparently more frequent; tapping operations would disclose their presence in trees where, perhaps, owing to little outward sign, they had not been suspected before. In parts of the tree not tapped their size, increasing with age, would ultimately result in their discovery.

The presence of nodules of several years' growth is at once detected by the characteristic, gnarled, and knotted appearance of the stem of a tree so affected. Tapping may be seriously interfered with, or even rendered quite impossible in trees badly affected. In a younger stage nodules may cause only a slight swelling externally, and they may then somewhat resemble the callus formed as a result of tapping injuries to the stem wood.

Swellings on the *Hevea* stem were shown by Petch (21) in 1905 to be of two kinds. The first kind is caused by wounding the cambium of the stem, usually by tapping too deeply.

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The wound thus produced is closed over in a manner common to trees in general, *i.e.*, the living cambium cells surrounding the wound undergo rapid division and give rise to a callus or cushion of tissue which grows over the wound area and ultimately covers up the wound. A swelling is thus formed over the site of the wound, but this gradually disappears in the subsequent growth in thickness of the stem. Thus, tapping is not interfered with permanently, though care is necessary when again tapping over this point to avoid grazing the woody swelling on the stem wood, if it is not yet merged in the subsequent growth. This healing process is known as "occlusion," and is a method whereby the tree covers up exposed wood areas and re-unites the severed edges of the cambial layer, so that one continuous cambium is again formed, and the stem can continue its normal growth in thickness. The new wood, however, never unites across the wound with the old wood, and in sections across the stem the wound is always visible. The cause of this kind of swelling being known, measures can be adopted to avoid producing it.

The second kind of swelling is due to the production of nodules. About the cause of the production of nodules much difference of opinion prevails ; several explanations have been advanced, but none so far has found general acceptance. A nodule at first is a little isolated body of woody tissue lying in the cortex, usually about the size of a "pea" when first observed, and easily "shelled out" with a penknife. There is little to indicate its presence at this stage—occasionally a small protuberance, or a slight cracking of the bark externally. In later stages these "peas" increase to the size of a "hen's egg," or many "peas" fuse together and form an irregular mass ; or, again, large sheets of woody tissue are produced. At the same time growing points originate, which grow inwards and unite with the stem wood, and thus ultimately the nodular masses become connected with the stem wood at many points. As the nodules grow larger the stem becomes gnarled ; the cortex cracks and latex oozes out ; finally, the entire stem to a height of 5 or 6 feet from the ground is affected. In this condition it is impossible to carry on tapping, and the tree is useless.

DISTRIBUTION.

Nodules have been recorded from every country where plantations of *Hevea brasiliensis* have been established ; they are found in Ceylon, the Federated Malay States, Singapore, Java, Sumatra, South India. One record (16) comes from Dutch Guiana ; this is noteworthy, as Dutch Guiana is on the reverse slope of the Amazon Valley watershed, and probably has *Hevea* indigenous to its flora.

In a report (1) prepared for the Brazilian Government, Akers says of the Malay Peninsula : " The worst pest brought to the notice of the Commissioners was the formation of burrs or nodules in the bark. While these do not materially affect the health of the tree, they are a serious interference to tapping. They occur principally on old trees that have been badly tapped in past years, but they are found also on trees that have never been tapped. Dr. Huber considers that they are the result of suppressed bud expansion combined with bad tapping, and this diagnosis is supported by Mr. Lewton Brain, the Director of Agriculture at Kuala Lumpur. Dr. Huber further thinks that they may be induced by the action of sun on renewed bark causing an irritation It is worthy of note that in the Amazon Valley, where the trees have been hacked about to a merciless extent by the use of the small axe (*machadinho*), these nodules are practically unknown."

It is interesting, in view of the statement contained in the last sentence, to read a report (2) on the Amazon Valley made by Akers for the Brazilian Government : " The older trees are hacked about in disastrous fashion Naturally the trunks have become a mass of wooden warts with only a thin covering of bark." Again, Akers says later : " At every stroke of the axe the cambium is penetrated Moreover, these gashes in a very short time transform the trunk into a mass of knots and warts, half the size of a man's fist, and over these only a thin covering of renewed bark is formed in the course of the next year or two."

As early as 1877 *Hevea* so deformed had been reported from Brazil. Cross in his report (9) to the India Office says : " From the ground up to a height of 10 or 12 feet the trunk was one swollen mass of warty protuberances and knots covered with

thick scales and flakes of dry bark." Aker's statement, that nodules are practically unknown in the Amazon Valley, was made before his visit to report on that place, and appears too sweeping. The "warty protuberances and knots" mentioned by Cross, the "mass of knots and warts" mentioned by Akers, and the presence of nodules in Dutch Guiana reported by the Department of Agriculture there are together good evidence that nodules are not "practically unknown in the Amazon Valley." We may conclude that nodules occur in *Hevea* in its native habitat in Brazil.

PREVIOUS RECORDS.

Gnarled stems early attracted attention in the East. Ridley in 1904 was the first to describe (25) knots on Para rubber trees: "They are perfectly harmless, and have no connection with any fungus or insect bite, but are due to the irritation caused by suppressed buds in the stem The only objection to them is that they often interfere with the tapping cut, but they are easily knocked out if so, and if left are usually covered up eventually by the later growth of the trunk and so disappear."

Petch in 1905 published a more detailed description (21): "The structure of these knots is identical with that of the 'maserknollen' (nodules) of beech and other trees. They are formed in the bark by an adventitious cambium, which has no connection with the main cambium of the stem."

In 1907 Ridley discussed (26) burrs more fully, and adduced some detail in support of his hypothesis, that they are derived from the abnormal development of dormant buds. He mentions that on some trees which had been tapped by the Brazilian method burrs had formed on the tapping cuts, and had later sent forth shoots. In the same Bulletin a correspondent describes nodules as occurring on tapped and untapped trees: the nodule begins as a small globule of wood, and has a spur point penetrating the main cambium and joining up with the wood of the tree. The suggestion is made that the pricker chips off and leaves small fragments of wood surrounded by cambium, and thus these unpleasant growths start.

Petch published a Bulletin (22) in 1909 on "Abnormalities in *Hevea brasiliensis*," in which is given the most detailed description of nodules up to that time, and the question of their origin is discussed. He found that nodules arise wholly in the cortex; they increase in size, and may fuse together to form woody plates; as they increase in size a projecting point appears on the inner surface of the nodule, and grows in towards the wood of the stem, with which it ultimately fuses. "The formation of this point appears to be due to the pressure exerted by the developing core, which apparently prevents the formation of normal cortex between it and the wood of the stem at the points of nearest approach." Latex obtained from the cortex over nodules is often of a yellow or chrome colour. Clots of almost dry rubber were obtained from pockets or cavities occurring where the cortex had died and become separated from the wood of the stem. Cross sections of nodules show a central nucleus of dead bark cells or of stone cells; round these a cambium had been developed, and had given rise to a nodule by laying down wood cells and fibres internally and bark cells externally.

Gallagher in 1909 attributed (11) the formation of nodules to early bad tapping, and believed them to be dormant buds. Later (12) he distinguishes three types of burr: his first two types are simply different stages of our nodule, his third type being the swelling due to the formation of wound wood on the main stem following a wound to the stem cambium.

Bancroft in 1911 published a paper (3) on the occurrence of burrs on *Hevea*. He distinguished between nodules proper and swellings due to wounding the stem cambium. The nodules he attributed to the natural habit of the tree to produce dormant buds, which fail to develop into shoots. These are stimulated to activity by tapping, and give rise to nodules. He mentions the production of woody masses in forest trees as a consequence of wounding or of increased illumination after thinning out; these woody masses originate from dormant buds stimulated to growth. "The burrs on *Hevea* are similar in all respects to these above-mentioned structures. They are in their nature and mode of origin buds which have failed to develop into shoots. The most convincing evidence in favour

of this is the abnormal occurrence in which shoots can sometimes be produced from such burrs, there being a definite organic connection between the shoot and the core of the burr."

Petch in his book on *Hevea brasiliensis* (23) considers that tapping has some effect in leading to the formation of nodules, and that there is no support for the statement that these burrs "work out" if left alone. "The production of burrs is not a universal habit of *Hevea brasiliensis*; indeed, they are comparatively rare on untapped trees freedom from burrs is a character which should be required in the selection of seed bearers." Petch comes to the conclusion that burrs are not caused by insects or fungi.

Rutgers in Java, in his description of canker in *Hevea* (27) in 1912, says that nodules are an after-result of an attack of canker. From behind the canker areas a brown colouration spreads out in streaks; these streaks reach the inner cortex and then expand and discolour large areas. These brown-coloured streaks and areas are composed of dead cells, and they remain in the bark long after the external cankered area has disappeared. They are apparently not caused by the fungus itself, but rather by poisonous products emanating from the fungus. The living cells round these dead areas begin to divide, and ultimately nodules are formed. Nodules are thus a secondary result of an attack of canker. Rutgers does not explain how the poisonous products, in their passage through the tissue intervening between the cankered area and the inner cortex, leave that intervening tissue unaffected. This appears to be a serious objection to his hypothesis.

Bateson translated (4) and discussed Rutgers' paper in 1913. Later he published a discussion (5) on the formation of nodules, in which he records from his observations that nodules arise on old leaf scars, although some occur between old leaf scars, and many occur at the base of old trees, where the leaf scars are totally obliterated. The vascular strand of the leaf passes through the cortex of the main stem and joins up with the central vascular system. When the leaf falls, the part of the strand in the main cortex remains there more or less isolated, and in the further growth of the main stem it loses its connection

with the central vascular system. The cells of the strand are carried sideways in both directions, and become scattered in small fragments along the whole length of the leaf scar. These cells are functionless, and may contain easily decomposable substances; the decomposition products would set up a state of irritation in the surrounding cortical cells. These would begin to divide and a cambium would arise, which would form cells round the point of irritation so as to isolate it from the adjacent healthy cells, and so a nodule would be formed. Bateson points out that this theory accounts only for nodules occurring on leaf scars, and suggests that for the formation of a nodule it is probably necessary to have only a small point of irritation; thus, local death of cortical cells, from various causes, might give rise to nodules in areas outside the leaf scars. He states further that this theory does not account for nodules occurring on tapped surfaces, where the cortex containing remains of leaf bundles is pared away.

A short note by Bateson (6) in a later Bulletin announces his discovery that the irritant present in the cortex is the coagulated latex in old latex vessels. This causes burrs to originate in both untapped and renewing bark.

Kuijper in 1913 gave a detailed account of the structure of nodules (16); he mentions the presence of a brown point or line in the centre of the nodule, consisting of ordinary cortical parenchyma cells, and occasionally a single sclerenchyma cell. These are surrounded by wood elements arranged radially round the brown centre, consisting of wood parenchyma with tracheidal elements and libriform fibres. Towards the periphery of the nodule the wood parenchyma is disposed in groups between other wood elements. Cells resembling wood vessels occur. The whole is enclosed by a cambium. The wood fibres are strongly curved and of irregular outline. In the cortex are found brown points and lines consisting of dead cell groups round which cambial activity sets in; this represents the first stage in the formation of a nodule, but the origin of the dead cell groups is obscure. Kuijper, after close examination, concludes that plant and animal parasites play no part, and that nodule formation is induced by tapping or otherwise wounding the tree.

In two later Bulletins (17 and 18) Kuijper considers that the formation of nodules points to the existence in *Hevea* of a strong tendency to produce abnormal growths, this tendency being accentuated by tapping or otherwise wounding the tree. Normally the cortex is subjected to internal pressure owing to the growth in thickness of the wood of the stem. In nodular cortex there is, in addition, the pressure owing to the growth of the nodules. This must have a disturbing effect on the tender cambium of the main stem, and probably this disturbance is manifested in the uneven, pitted, and ridged surface of the wood of the main stem under areas of nodular cortex. He contends that the pricker has no effect in inducing nodule formation in normal trees.

Rutgers and Arens (28), in a paper printed for the Rubber Exhibition at Batavia (1914), discuss nodules as the result of an attack of canker (*Phytophthora Faberi* Maubl.). The fungus kills small points and lines of cortical tissue, and these areas of dead cells act as an irritant on the surrounding healthy cells, which then divide to form a cambium, and so nodule formation is begun. Rutgers, after a short visit, claimed to have found *Hevea* canker caused by *Phytophthora Faberi* in the Federated Malay States; but this cannot be held to be conclusive, as it is not borne out by the work of Federated Malay States mycologists. Cf. Brooks (8). The presence of nodules in the Federated Malay States is well known; thus, under the circumstances, canker cannot be satisfactorily considered as the cause of nodule formation.

Richards and Sutcliffe, in the Straits Settlements, in a pamphlet (24) issued in 1914, consider the question of the formation of nodules. They accept Bateson's theory of the development of nodules on old leaf scars, the stimulus to nodule formation being the irritation set up by the coagulation or decomposition of the latex in the fragments of latex vessels remaining from old leaf traces. They apply the theory to the formation only of pea-like nodules. The plate and sheet nodules are formed round the outer latex vessels, as they are gradually pushed outwards and broken up by the new cortex which is continually being formed by the cambium; the stimulus to nodule formation is again the irritation set up by

the decomposition of the contents of these latex vessels. In the course of tapping latex vessels may be severed above and below, and the latex in the remaining portion may coagulate or decompose and so inaugurate nodule formation. The latex does not appear to coagulate in the latex vessels, but rather seems to exude into the surrounding cells. The authors admit the difficulty that only a few leaf traces give rise to nodules, and only a few stems tapped or untapped have nodules present; their theory would require nodule formation to be the rule rather than the exception.

Keuchenius (14) in 1914 discussed the effect of the pricker in inducing the formation of nodules, and came to the conclusion that the pricker was the chief agent, but that nodules might also be formed as the result of injury from fungus or insect attack. The pricker, especially if the teeth are blunt, tears the cortex and pushes cells bodily out of position. The pricker marks are healed up in the usual way; a cambium forms round them, which produces cork cells externally, and so closes the wound in the cortex. The bodily displaced cells, however, become a source of irritation to the surrounding cells, which then begin to divide, and so give rise to a nodule. It can, however, no longer be maintained that the pricker is even the chief cause, as the pricker has fallen into almost complete disuse; yet nodules are found on many trees now in tapping, but to which the pricker has never been applied.

Bateson in 1914, in a later Bulletin (7), expands his theory of the origin of nodules. He states that "Coagulation of latex inside the vessels takes place normally in the outer cortex, and does not apparently give rise to burrs. From this it may be inferred that the cells of the outer cortex have lost their power of responding to this particular stimulus by forming a cambium; the cells of the inner cortex being younger are probably more easily stimulated into a resumption of cambial activity." From the evidence adduced later it will be seen that this statement is open to some doubt, as inception of nodule formation was observed to occur almost invariably in the outer cortex.

Bateson cites three causes which may lead to the isolation of latex vessels, stagnation of movement of the latex in the

vessels, and consequent formation of nodules ; these are (1) leaf-fall, (2) disease, (3) wounds. In the case of disease, healthy patches of cortex may be isolated by the diseased tissue, and in these patches nodules are found. Exhaustive tapping is considered as a further cause of the development of nodules. His conception of root pressure is faulty, and the assumption of a diurnal vertical movement of the latex in the latex vessel under the influence of this root pressure is unwarranted on the evidence led. The evidence cited applies normally to every *Hevea* tree ; we would therefore, on this theory, expect to find nodules occurring as the normal condition ; actually they are found only on a very small percentage of trees.

In the present Paper a clear distinction is drawn between "nodules" and "globular shoots." By "nodules" is understood the woody structures formed round altered latex vessels. "Globular shoots" are the spherical woody structures formed as the result of the slow growth of dormant buds, which have lost their vascular connection with the stem. These latter comprise the great majority of the structures found in untapped trees.

MACROSCOPIC APPEARANCE.

Stems with large nodular growths are externally strongly gnarled and warted. The area of stem affected may range from quite a small patch of a few inches across up to an area comprising the whole circumference of the stem to a height of 5 or 6 feet. The surface of the bark is covered with warts and protuberances ; deep cracks and fissures abound, from which latex often of a yellow or chrome colour oozes out and coagulates.

In the early stages the nodules are little spherical or elongated bodies of 1 or 2 millimetres diameter, which can only be detected with difficulty. The first outward indications are a slight raising and cracking of the bark. The nodules at this stage are like little "peas" of wood lying in the cortex, from which they can easily be "shelled out" with a penknife. The nodule separates from the cortex along the line of the nodule cambium ; between this and the stem cambium there is a layer of normal cortex.

Where several small nodules occur close together their cambial layers may meet and unite, thus producing a multiple nodule. Often a large nodule in its growth meets and fuses with small nodules, which then appear as excrescences of the large nodule.

The older nodular masses vary considerably in size and shape. Some specimens are much developed in thickness, and project very considerably from the surface of the stem; some of these measure 3 or 4 feet in length, 6 or 7 inches in breadth, and 3 or 4 inches in thickness. At other times a plate or sheet of nodular tissue is formed. One such plate at Peradeniya measures 4 feet 9 inches long, 6 inches broad in the middle, and 1 to 2 inches thick.

Occasionally nodules are obtained which exhibit a network shape strongly resembling the network of a latex vessel cylinder in tangential section. This type of nodule exactly represents what would occur were the latex vessels to be encysted by layers of woody tissue, and as will be seen later this appears actually to be the case.

At a very young stage nodules of only a few millimetres diameter may develop a vascular connection toward the wood of the stem; some nodules apparently never develop any vascular connection. This vascular connection ultimately reaches the wood of the main stem, the cambial layers unite, and the wood of the nodule thus becomes united with the stem wood. As the nodule grows more vascular connections are formed, and thus large nodules become united with the stem wood at many points. In the case of thick, massive nodules large areas of the nodule may become united with the stem wood, but no cases have been observed of complete fusion between nodule and stem. In the case of plate and sheet nodules fusion occurs to a lesser extent, the vascular connections remaining more or less isolated. Hence between such large nodules and the stem wood there are considerable areas of the original cortex.

Similar vascular connections are sometimes developed from the stem cambium and proceed in an outward direction toward the nodule. In addition, the surface of the stem wood is pitted, these pits corresponding in position with the vascular connections from the nodule. The surface of the stem wood

and of the nodule is irregular, corresponding with irregularities on the adjacent cortical surface, the condition being due to unequal cambial activity under the abnormal state of the tissues. The surfaces of nodules are marked with raised ridges running in parallel undulating lines and in places describing whorls. Similar raised undulating lines can be traced on the stem wood in many instances.

On cutting into nodular cortex, pockets or cavities of several inches diameter containing rubber are frequently encountered ; occasionally these are lenticular in form. Petch (23) states as follows : " I have taken three ounces of almost dry rubber from such a situation." These cavities may have been formed by the rupture of the cortex under the internal strains set up by the developing nodule. Latex would then flow from the ruptured latex vessels into the cavity and would coagulate there. Such pockets of rubber are likewise found in trees subsequent to attack by parasitic fungi, more particularly after attacks of canker (*Phytophthora Faberi*).

Nodules do not extend to the parts of the plant below ground ; they are not found on the roots even when these are exposed to the air, though the stem may be badly affected down to the ground level.

Nodule formation appears to spread out in all directions over the stem from the point of origin.

Untapped trees up to eleven years old have been examined in large numbers, but not one case of large, massive nodular growths has been found by the writer on such trees.

STRUCTURE.

Transverse sections of nodules show three zones of tissue :—

- (a) A central core, dark brown in colour, appearing as a point or line. It consists of cortical elements, and represents that portion of the original cortical tissue round which cambial activity started in the formation of the nodule.
- (b) Surrounding the core is a zone of wood elements derived from the nodule cambium. These form the bulk of the substance of the nodule.
- (c) On the outside is the nodule cambium with the few cortical cells which it cuts off externally.

(a) Central Core.

The central core, in transverse sections, appears to the naked eye as a dark brown point or line, and in longitudinal sections as a brown line or plate respectively. It consists of one or several latex vessels surrounded by cortical cells containing a dark brown tannin, and outside these a few cortical cells without tannin.

In normal cortex transverse sections show the latex vessels disposed in concentric rings; thus, in a length of stem they could be represented diagrammatically by a series of cylinders fitting one inside another, but separated from one another by approximately equal spaces. While the latex vessels of any one cylinder branch and anastomose abundantly within that cylinder, they do not form any connections with latex vessels of neighbouring cylinders. Each cylinder is thus completely isolated from adjacent cylinders. The latex vessels are accompanied by prosenchymatous cells, some of which have a tannin content; such tannin cells are isolated or occur in little rows. The latex vessels with their prosenchymatous cells and the sieve tubes and companion cells pursue a parallel course; when they encounter a medullary ray in their vertical course in the cortex, they diverge and pass round it. In tangential sections, therefore, the medullary rays appear to lie in pockets or enclosed areas formed by the latex vessels, prosenchymatous cells, sieve tubes, and companion cells.

In a nodule the central core shows all these points of structure. The latex vessels in the core are derived from only one latex cylinder, as there is only a single row of them. They are accompanied by prosenchymatous cells, and in longitudinal sections the medullary rays are observed to lie in pockets formed by the latex vessels, prosenchymatous cells, sieve tubes, and companion cells. The tannin cells here completely surround the latex vessels in varying numbers, but much more abundantly than in normal cortex. The central core thus consists of a patch of cortical tissue, which has been encysted by the formation round it of a cambium which produces wood cells.

The presence of latex vessels can be demonstrated by staining and maceration. The rubber content stains pink

with tincture of alcannin, and reddish orange with Sudan glycerine, and the characteristic, contorted appearance of a strand of rubber is plainly evident. Digestion of sections in Schulze's maceration mixture for 30 minutes in the cold leaves the rubber content intact, while other cell contents are dissolved. Sections of nodules freshly taken from a tree show that the latex vessel content is already coagulated ; no latex oozes out from the cut surface of the central core.

Tannin cells surround the latex vessels of the core in a layer of varying depth. Some cells contain a yellowish tannin, which readily turns blue with ferrous sulphate solution, and appears not to differ from tannin in normal cortex. Similarly, just as in normal cortex, cells with a dark brown tannin content are present. A few of these readily turn blue with ferrous sulphate, but the majority are acted on only very slowly, and apparently contain an insoluble tannin or tannin compound, which is highly resistant even to Schulze's maceration mixture.

In the core the cell walls of the latex vessels, the latex vessel content, and the cell walls of the tannin cells and of the neighbouring cortical cells are all of a yellow colour. This colouration appears to be due to the infiltration of some coloured substance. In some places only the middle lamella is coloured, and occasionally the colouring matter is found occupying neighbouring intercellular spaces. Again, only the secondary thickening layers of a cell wall may be coloured. Generally, however, the whole wall is coloured. The colouring matter permeates the tissue in such a way as to suggest diffusion from the latex vessels of the core. The colouring matter is not acted on by iron salts ; in a tannin cell the content turns blue, but the wall remains yellow. It is insoluble in alcohol. With 1 per cent. osmic acid the tannin content rapidly turns blue or black, but the walls darken only very slightly and slowly. The yellow colouration is probably due to the production of some decomposition product in the latex vessels ; its subsequent diffusion into the surrounding cells results in the staining of the cell walls. This is the first symptom of the change in the latex vessel content. Sections of nodular cortex showing very early stages have been obtained ; and these show the inception of nodule formation

round latex vessels belonging to the same latex vessel cylinder. Some latex vessels are surrounded by cortical cells, whose walls show the yellow colouration only. Round adjacent latex vessels the cortical cells have yellow coloured walls and, in addition, an abundant tannin content. Further, some of these last show cell division beginning in the neighbouring cortical cells. The diffusion of this yellow colouring matter appears to stimulate the cells to the production of tannin; possibly the tannin is secreted as a means of protection against the poisonous effects of the yellow colouring matter.

The cell walls of the latex vessels and other elements in the central core are thickened, often strongly thickened. The cell walls are lignified and take on all the lignin stains. The fact that the latex vessel walls are lignified indicates that the lignification occurs subsequently to the inception of the nodule. The other lignified cells are ordinary cortical cells, and have no resemblance to the stone cells of the cortex: their thickened walls are not striated and pitted as are the walls of stone cells. Stone-cell groups occasionally occur in the core as accidental inclusions.

Starch is found in the core in varying quantity, and crystals of calcium oxalate may also be seen.

(b) *Wood Elements.*

These consist of cubical wood parenchyma cells, medullary rays, tracheides, short tortuous vessels, and fibres.

The cubical wood parenchyma cells are the first productions of the nodule cambium, and immediately surround the central core. They are disposed in a regular manner radiating out from the centre.

The medullary rays are similar to normal medullary rays, and also radiate out from the centre. They can often be traced continuously from the cortex into the nodule, right across the nodule, and into the cortex beyond again. The nodule cambium thus lays down medullary ray cells continuous with those in the cortex. This facilitates the transport of food material into the nodule and its storage as starch, which is sometimes very abundant. A little tannin may occur in the medullary rays.

Near the centre wood vessels are absent, but they are produced in increasing number toward the outside. They are a little narrower in lumen than normal vessels, and are extremely tortuous. They have a longitudinal course in the nodule, and terminate abruptly at each end. They have large bordered pits as in normal wood.

The libriform fibres are found at the ends of the nodule mainly, where the surface is very sharply curved. At these points wood parenchyma cells are at first produced, but the growth of the nodule entails a very rapid increase in surface. To meet this the cambium cells elongate, and cut off correspondingly elongated wood parenchyma cells. The elongation continues, and long prosenchymatous cells are produced. These cells are interwoven with one another, due perhaps to irregular elongation or curving of the cambium cells under the internal strains set up in the tissue by the growing nodule. Isolated cells can be obtained by maceration; they exhibit many fantastic and bizarre shapes. These are the libriform fibres, but it is possible that in elongating some of the prosenchymatous cells develop abnormal shapes, or that tracheides may also be thus changed.

Over the rest of the surface of the nodule, with increasing girth, the wood parenchyma cells undergo a similar elongation, but to a lesser extent. A cambium cell undergoes for a time ordinary tangential division and consequent elongation; it then divides radially, so that two daughter cambium cells are formed in its place. These undergo the same cycle in the further growth of the nodule.

In large nodules the outer layers are nearly normal. Twisted and curved elements disappear, the vessels pursue a straighter course, and there is little to distinguish the sections from normal wood.

The central core is sometimes excentric, owing to more rapid growth on one side of the nodule than on the other.

The starch content of the wood parenchyma and medullary rays is often abundant.

The vascular connections of nodules, which ultimately join up with the stem wood, are exactly similar to the vascular connections on globular shoots. The vestiges of such vascular

connections are frequently found completely overlaid by layers of wood tissue produced in the subsequent growth of the globular shoot. Exactly the same feature is found in some typical nodules, where aborted vascular connections occur completely sunk in the tissue of the nodule. In globular shoots, under suitable change of conditions, growth may be resumed, and disconnected vascular connections again become connected with the stem wood. The vascular connections of nodules arise under conditions of activity in the cortex, and their whole appearance and occurrence suggest a close analogy with those of globular shoots.

(c) *Nodule Cambium.*

The nodule cambium arises from cortical cells, which become active and begin to divide. It cuts off wood cells internally and cortical cells externally, the latter only to a small extent. Latex vessels are produced externally by the nodule cambium only after a long period of division, and then only sparingly. In the cortex overlying old nodules the latex vessels are scanty ; this is very noticeable in sections ; and in the field, in tapping such cortex, a poor yield of latex is obtained. It will be seen from the following that such cortex may with good reason be considered as entirely the product of the nodule cambium.

In normal cortex two zones can be quite clearly distinguished, *i.e.*, the inner cortex and the outer cortex. The inner cortex in longitudinal section exhibits well-developed latex vessels, sieve tubes, cortical cells mostly prosenchymatous, comparatively few cells with tannin content, no stone cells ; and the medullary rays are quite distinct. The outer cortex is marked by the presence of abundant stone cells, fragmentary remains of latex vessels, and abundant tannin cells ; the medullary rays are indistinct, and the cortical cells are hexagonal or isodiametric.

In the cortex overlying old nodules the inner cortex is normal. The outer cortex differs strongly from the normal in the almost entire absence of stone cells and the much greater abundance of tannin cells. The absence of stone cells is very noticeable in cutting sections ; it is extremely difficult to obtain sections of normal cortex, whereas nodular

cortex cuts easily. Correlated with the absence of stone cells in the outer cortex are the following :—The medullary rays are distinct, the latex vessels are continuous, and the difference between inner and outer cortex disappears to some extent. There is, however, a slight difference, in that the outer cortex has a greater abundance of tannin cells, and the cortical cells are isodiametric. Such differences in the structure of the cortex, more particularly the absence of stone cells in the outer cortex, could not be brought about by changes in the original cortex. Further, old nodules of large size effectively exclude the stem cambium for contributing cells towards the renewal of the cortex ; hence, in the course of time nodules would be exposed by the gradual shedding of the cortex as bark. Tissue thus shed as bark cannot be made good, unless the nodule cambium cuts off cortical cells. The fact that old nodules are not exposed, and the abnormal structure of the cortex covering them, indicate that the nodule cambium produces cortical tissue. This cortex produced by the nodule cambium may become very thick ; some specimens are almost twice the thickness of normal cortex.

After a longer or shorter period of growth the nodule cambium develops a projection directed towards the stem cambium. The two cambia finally meet, merge into one another, and continue to produce wood cells internally. Thus, a bridge of wood cells is formed joining up the wood of the nodule with the wood of the stem. This may proceed simultaneously at several points on the same nodule and several connections be formed, but these remain isolated, hence the inner surface of the nodule never becomes wholly fused to the wood of the stem. In old nodules there are many connections, but there still remain areas of cortical tissue between the nodule and the stem wood.

The writer has obtained radial sections of cortex in which the inward-growing projection of a nodule had a corresponding projection proceeding outward from the stem cambium to meet it.

Sections show that the inward-growing projection of a nodule may cause the stem cambium to lag behind in activity of division in its vicinity, so that a depression or pit is gradually formed in the stem wood. Generally the abnormal strains

set up in the cortex by the growth of the nodule would result in irregular cambial activity, and thus ultimately in a pitted and warty surface. This is probably the mode of origin of the majority of the pittings on the stem wood and on the nodule.

NODULAR CORTEX.

Under this heading will be considered cortex in which nodules are developing. Sections of nodular cortex showing early stages of nodule formation can be readily obtained. Round a developing nodule the cortical tissue is much compressed and distorted. Cells are pushed outwards from the centre of formation and come to lie concentrically round the nodule. Sometimes stone-cell groups are thus displaced and form an almost complete ring, or an entirely complete ring, round the young developing nodule. It is obvious that the formation of a nodule sets up in the surrounding cortical tissue unusual internal strains, which would have an immediate effect on dividing cells and even on mature cells. This probably accounts for the abnormal shape of cells and the abnormal curvature of cell walls often seen. The inner cortex is in nearly every case quite normal; nodules originate in the outer cortex at varying distances from the inner cortex, or very rarely in the inner cortex.

Old nodules are often of considerable size and of various forms; roughly, they form either plates or rounded masses of nodule tissue. Sections through the central core show that cell division begins simultaneously round several adjacent latex vessels in the same cylinder, and that the several cambia on coming into contact merge into one another and form one continuous cambium round the whole. A large nodule in its development may come in contact with small nodules near it and fuse with them. This is plainly seen in the external appearance of some nodules which seem to have small nodules adhering to them; sections show that the central core of the small nodule is not connected with that of the large nodule. By such continued fusion, plate or sheet nodules may arise; but more often these appear to arise by the growth of a nodule from its point of origin along the ramifications of a latex vessel cylinder or by simultaneous encrusting of the latex

vessels over a large area. Nodules occur, which branch and have a distinct net structure ; there are open meshes where growth has proceeded along the latex vessels only, and left the intervening cortical tissue unchanged. This intervening cortical tissue consists of medullary rays, as the meshes formed by the ramifications of the latex vessels in normal cortex are occupied by the medullary rays.

In gouging a nodule out of the cortex a brown point is frequently observed at each end of the nodule, and this is seen to coincide with a similar brown point in the cortex. These brown points are the altered latex vessels and their neighbouring cells. The central core of the nodule is here continuous with the cortical tissue ; the nodule would probably continue its growth along the latex vessels thus altered.

In nodular cortex, which is still more or less normal, longitudinal sections show the presence of vertical areas of abnormal tissue consisting entirely of parenchymatous cells. These areas differ from the surrounding tissue in being free from tannin and stone cells, and in having abnormally curved cell walls. They appear to arise as the result of indefinite cell division over a small area, and occur generally between the inner and outer cortex. The medullary rays are quite distinct in the cortical tissue on either side of the abnormal area, and can sometimes be traced through it. This indicates that these areas arise subsequently in the cortex. They stand out prominently in sections as white areas amid the surrounding tannin-stained tissue. It might be suggested that the cortex is stimulated to this indefinite cell division by the presence of irritant substances diffused from the altered latex vessels, or that bud primordia are stimulated to growth and develop abnormally. Such abnormal areas have no definite cambium, and twisted cells with curved cell walls occur, which resemble the twisted tracheides of nodules, but are not lignified. Occasionally these areas are produced in the inner cortex near the stem cambium, when the cells of the inner cortex may be displaced and disposed in undulating lines, giving a tissue which strongly resembles that in the vicinity of developing vascular connections. In one case sections showed a developing bud structure with a definite cambium

situated inside an area of abnormal cortex. In other cases the abnormal areas consist of twisted and curved cells with abundant tannin content ; often these cells are disposed in the form of a whorl, and have been derived from cortical cells by indefinite division, the tannin content apparently not having any inhibitory action on cell division. The cortical cells surrounding abnormal areas always have an abundant tannin content.

A case was observed where altered latex vessels occurred in the inner cortex near the stem cambium ; they were surrounded by a layer of tannin cells, and cell division had just set in. The same section showed a developing globular shoot with its vascular connection almost joined to the stem wood, the whole being in contact with some altered latex vessels in the inner cortex. This appears to be a satisfactory case of the production of a globular shoot from an adventitious bud in tissue stimulated to activity by the presence of altered latex vessels.

Sections of both nodular cortex and normal cortex frequently exhibit brownish-coloured streaks. These coloured streaks are most abundant in nodular cortex, and occasionally are seen in the above-mentioned areas of abnormal tissue and near developing nodules. This brown colouration appears to be confined to the walls of the latex vessels ; it gives no reaction with iron salts.

The bright yellow colouration and highly refractive walls of altered latex vessels in nodular cortex are quite distinct from the brownish-coloured cell walls above described. The yellow walls of latex vessels in nodular cortex have no doubt some connection with the chrome-yellow latex sometimes obtained from nodular trees ; normal latex is white. It would appear probable that some substance in the altered latex vessels of nodular cortex is of a yellow colour, and imparts this colour to the walls. In some cases nodular cortex yields a normal white latex ; here probably the alteration of the latex vessel content has ceased.

Nodules to a small extent are shed with the bark scales. On old *Hevea* trees in the Royal Botanic Gardens, Peradeniya, the writer has found dead nodules of fair size in dead bark scales which were on the point of dropping to the ground. One such nodule was 2 inches long. Other large nodules were

partially protruding from the bark, and were exposed on their outer surface. The exposed side was dead and dried up ; the inner side was still in living connection with the cortical tissue. It would be merely a matter of time till these nodules dried up completely and fell away with the bark scales. The writer has observed a similar condition on trees on estates, where the trees were much younger. In both cases other nodules were present which had joined up with the stem wood.

In cutting sections of nodular cortex one may find, in the outer cortex, small reddish-black points, which are extremely brittle, and crumble away before the razor. They appear almost as foreign bodies lying in the cortex, and easily separate from the surrounding tissue. They consist of portions of the cortex, including abundant stone cells and some cortical cells and latex vessels, all saturated with tannin. Sections can with difficulty be obtained, and require treatment with concentrated nitric acid to render them transparent, the tannin being then dissolved. Stone cells are by far the most abundant ; the remaining tissue is normal. The tannin here is probably secreted as a means of protection against some injurious effect emanating from these points. The nature of these reddish-black points has not been determined.

NODULES IN UNTAPPED TREES.

The first material collected from an untapped tree consisted of two specimens obtained from near the base of a five-year old *Hevea* on the Government Experiment Station at Peradeniya. Sections of these showed no latex vessels in the core, and the tannin cells so characteristic of nodules were entirely absent. These specimens were undoubtedly globular shoots derived from latent buds.

It became evident that the statement that nodules occur on untapped trees required some definite proof of its accuracy. Accordingly, 2,000 trees seven years old and untapped were examined. These trees formed part of a field on an estate. The result was as follows :—

121 trees had globular shoots, *i.e.*, 6·05 per cent.

6 trees had nodular structures of various types, *i.e.*, ·30 per cent.

No trees had true nodules.

In the 2,000 trees not one case of large nodular masses was observed, nor have such cases ever been noticed in untapped trees examined on many estates in various parts of Ceylon. It may be objected that untapped trees are too young to show nodule formation on a large scale. On one estate eleven-year old trees which had been in tapping only two weeks were examined; no trees showed large nodular masses. On the Experiment Station, Peradeniya, six-year old trees were brought into tapping in 1910, and in 1912, when eight years old, had developed large nodular masses in many cases. Tapping thus apparently supplies conditions favouring the rapid growth of nodules, though it is not necessarily an essential factor in their inception, and age is a negligible factor.

Nodules can be distinguished from globular shoots with certainty only under the microscope. A nodule when cut through the centre exhibits a dark brown point or line at the centre of the cut surface, and this can be used as a rough means of distinguishing it from a globular shoot, which has no such colouring. In the nodule the dark brown colour is due to the presence of the tannin cells surrounding the altered latex vessels. Globular shoots in untapped trees have evidently been frequently mistaken for nodules, and probably are usually the bodies in question when nodules are stated to occur in untapped trees.

Of the six cases of nodular structures obtained in the 2,000 untapped trees, three were found in the callus at the edge of long vertical wounds. In these the structure was not typically nodular; the rubber strands in the core occupied a cavity into which the latex had evidently oozed and coagulated. The cavity may have originated through internal lesions in the cortex, or through slight wounding by some external agency.

In the fourth case there was a large cavity filled with rubber at the base of a globular shoot; the cavity was closed over by subsequent layers of wood elements. The wood tissue of the structure at this point showed signs of a former callus nature, and without doubt this was a case of a globular shoot which had become exposed, possibly through the natural shedding of

the bark, or through some injury, as this case was obtained from the callus of a vertical wound. This exposure was accompanied by outpouring of latex, and the callus formed at the exposed area of the globular shoot included the coagulated latex in the process of occlusion.

The fifth case showed no central cavity. In its place there was a core resembling somewhat a leaf-trace and coloured greenish-yellow like the colour of latex vessels in the core of true nodules. Surrounding this core was a shallow layer of tannin cells. Maceration failed to disclose the presence of rubber in the core.

The last case had a core composed of a fairly large portion of cortical tissue with several stone cells present. Maceration showed up two small particles of rubber indicating the presence of latex vessels, but these were in nowise altered, and cannot be taken as being the cause of the formation of the woody sphere. Surrounding the core, again, was a shallow layer of tannin cells, and the neighbouring wood tissue also had a considerable number of cells with tannin contents.

These last two cases are of considerable interest, as here we have instances of the encysting of cortical tissue under conditions other than the alteration of latex vessel content. This condition approaches very closely the condition in beech nodules described by Krick (15).

Here may be mentioned another type of nodule found in nodular trees generally and of not uncommon occurrence. In this type maceration of transverse sections shows the cells of the core embedded, so to speak, in rubber. There is no lesion of tissue. The latex has apparently oozed out of the latex vessels and coagulated in the neighbouring intercellular spaces. Richards and Sutcliffe (24), amongst an excellent series of microphotographs, show a good example of this type of nodule.

GLOBULAR SHOOTS.

Under globular shoots are considered those spherical woody bodies which are found isolated in the cortex, and do not possess a core as in nodules.

Where *Hevea* has been pollarded, strongly growing adventitious shoots develop just below the cut surface. They appear

at first as spherical woody protuberances, which attain some size, and then send out a shoot. The protuberances in early stages have no connection with the stem wood, and therefore are derived from dormant or latent buds, and not from adventitious buds, which arise endogenously, and would thus have their vascular strand in connection with the vascular system of the stem. Very often the spherical woody body produced by the continued growth of such dormant buds, after they have lost their connection with the wood of the stem, can be detected at the base of shoots developing near the cut surface of pollarded trees. Sections through such developing shoots show that they consist of wood parenchyma, wood fibres, tracheides, and vessels. The tracheides are curved and the vessels somewhat tortuous, but they are continuous. Later a vascular strand, consisting mostly of tracheides and wood parenchyma, connects the developing shoot with the stem wood. In the centre of the base of the shoot the fibres are much curved and irregular, but become normal in the outer layers, the irregular structure indicating the position of the spherical woody body from which the shoot developed. The vascular connection with the stem wood is formed by a growing point directed inwards from the developing shoot tissue towards the stem wood.

Sections show that the spherical bodies are composed of twisted tracheides and wood fibres, with here and there a tortuous vessel, the several elements being interwoven in a highly irregular manner at the centre and becoming normal towards the outside. A cambium is present which produces a small amount of cortical tissue and latex vessels, the latter being determined as the product of the nodule cambium by their concentric disposition round the spherical body. On the inner side and directed towards the stem there is frequently a tapering point consisting of wood elements and resembling closely the vascular strand of a shoot. This undoubtedly represents the former connection with the wood, but in many cases it is entirely wanting. In some of these cases sections disclose the former connection completely sunk in the tissue of the spherical body; the tapering point has ceased growth, and has been covered over by the subsequent

layers of tissue laid down by the cambium of the spherical body. In other cases no trace of a former connection can be found, and here no doubt the bud primordium has lost connection with the stem at a very early stage before the appearance of vascular elements in the connection. Occasionally, amongst the last-named cases, a small protuberance may be found on the surface of the spherical body, apparently an attempt by the spherical body to develop a vascular connection with the stem. Under favourable conditions, as, for example, if the tree were pollarded, this protuberance would join up with the stem and the spherical body would grow forth as a shoot. Some specimens of these spherical bodies have vestiges of a shoot directed outwards, and sections have been procured which show a typical vegetative cone with leaf rudiments and rudimentary axillary buds.

The spherical bodies are thus shoots, and might be called globular shoots, as described by Strasburger (29). The sprouting of nodules mentioned by Ridley (26) and Bancroft (3) were probably cases of globular shoots stimulated to further growth by changed conditions. A specimen at Peradeniya shows a globular shoot of spherical outline without any external vestige of a connection with the stem, which has developed a shoot 4 inches long bearing a small leaf at its apex.

The material collected from the 2,000 untapped trees already referred to was classified as follows :—

- (1) Material collected from old leaf-scars.
- (2) Material collected from areas where the bark exhibited no marking.
- (3) Material collected from wound callus.
- (4) Material collected from the fork of trees with forked stems.

(1) *Material from Leaf-scars.*

The leaf-scars remain distinct on old stems up to six or seven years of age ; they appear as a horizontal line of depression 4 or 5 inches long, with a shallow pit in the middle. Generally, buds if present are dormant, and give no external evidence of their presence. In some cases, however, these dormant or latent buds of the old leaf axils lose their connection

with the stem wood, but continue a process of growth, which results in the production of globular shoots lying isolated in the cortex. These bodies vary from the smallest size up to 3 or 4 centimetres diameter, and may be single, or several may be fused together in a horizontal row along the leaf-scar. Globular shoots have been obtained from the cortex of seven-year old trees; hence the rate of development appears to be much more rapid in *Hevea* than in the beech, where similar bodies are found.

(2) *Material collected from Areas where the Bark exhibited no External Marks.*

This material agreed with the leaf-scar material; in fact, it is highly probable that it should be considered as leaf-scar material, the leaf-scars having disappeared in the older bark from which this was obtained. Cases occurred where the globular shoots had fused together in a horizontal row, exactly as in the case of leaf-scars.

Two specimens were obtained which showed a deposit of tannin in scattered cells in the centre. This unusual secretion of tannin may have been due to conditions present before the latent bud had resumed activity resulting in the formation of a globular shoot. The tannin content was light coloured and readily turned blue with ferrous sulphate solution.

These first two classes of material comprised nearly the whole of the collection from the 2,000 trees.

(3) *Material collected from Wound Callus.*

Only seven specimens were obtained, and these were typical globular shoots save one, which was considerably elongated.

(4) *Material collected from the Fork of Trees with forked Stems.*

A few globular shoots were obtained which resembled in all respects leaf-scar and wound-callus material.

Trees are frequently seen which have been blown over by the wind or have otherwise been caused to fall; they may have only a few lateral roots still in the ground, yet along the whole

upper surface of the stem a copious production of new shoots occurs. These are derived from the latent buds which are stimulated to growth by the altered conditions. This indicates the readiness with which *Hevea brasiliensis* responds to changed conditions, the latent buds and globular shoots if present growing out into normal shoots. Similarly, standing trees if scorched by fire throw out large numbers of shoots from the adjacent unharmed cortex.

On leaf-scars a row of globular shoots may be found fused together to the number of five or six individual shoots ; this demonstrates that several buds are laid down in each leaf axil and remain latent, unless conditions change and become suitable for a resumption of activity.

In both tapped and untapped trees globular shoots are occasionally obtained which have a central core of very small cells with strongly thickened walls. In these the vascular connections are completely wanting, nor do any cases occur where the vascular connection has been covered over in the subsequent growth of the shoot. Here undoubtedly the bud has lain dormant for some time and has slowly developed thickened walls, while at the same time the pressure of the surrounding tissue has prevented the cells from increasing in size. The absence of any point which might represent a vestigial vascular connection with the stem shows that the bud early lost connection with the stem and remained in a completely dormant state. Later, under some change of conditions, cell activity set in in the cells adjacent to the mass of small thickened cells of the bud, and resulted in the production of a globular shoot.

Many globular shoots consist entirely of wood elements, more or less tortuous, and show no traces of a former connection with the stem wood. In these the bud primordium may have become separated from the stem wood at a very early stage before the vascular connection had become differentiated into wood elements.

In the course of growth globular shoots are pushed outwards, and may come to have their outer surface exposed. In many cases the exposed surfaces are again covered over with tissue, but they are readily distinguished in sections owing to the

abundant deposit of tannin in the adjacent cells, and the arrangement of the cells in the covering layers as in the callus in wounds. Latex may ooze out and coagulate on the exposed surface and later be included within the covering layers, and thus give the structure a fictitious resemblance to a nodule.

Large nodules in their development may meet with globular shoots, or may stimulate dormant buds to activity. These fuse with the tissue of the nodule on coming into contact with it, and later throw out vascular projections towards the stem wood. In some cases vascular projections might already be present when fusion occurred with the nodule. This does not account for all vascular connections of nodules, as in some nodules the vascular connection can be traced right into the altered latex vessel region of the core. It is possible, however, that even in these cases, at the inception of cell division near the altered latex vessels, a bud primordium was present, or that the cortical cells on being stimulated to activity developed bud or shoot characters.

Globular shoots never develop into large masses of woody tissue. The largest specimens obtained measured approximately 1 inch in diameter.

GENERAL.

Isolated wood bodies occur in the cortex of other trees. Sorauer's investigations (19, p. 183) on nodules in apple trees showed that the central core consisted either of hard bast elements or of cortical parenchyma cells; the outer layers of wood elements were similar in structure to the wood elements of *Hevea* nodules. Sorauer was of opinion that apple nodules arise as a consequence of wounding, as they are readily formed in the vicinity of wounds. He describes short woody strands which he found in the cortex of pear trees; these had a central core as in apple nodules, but the wood elements were arranged parallel to those in the adjacent wood. Sorauer considered these strands to be new formations.

Krick (15) minutely described the woody nodules found in the cortex of the beech, and distinguishes two types: (1) nodules bearing buds or shoots; the wood of the bud or shoot can be traced continuously right through into the nodule;

and (2) nodules independent of buds, which are again divided according as the central core consists of wood elements, of bast elements, and of cork tissue. Wood elements form the core in the majority of nodules, cork tissue is found in some, and bast elements were observed in only a single case. The nodules which occur in connection with dormant buds or abortive shoots, which have subsequently become separated from the stem wood, must be clearly distinguished from those nodules which originate as isolated bodies in the cortex. Krick thus considers beech nodules to arise from dormant buds and abortive shoots, or to be new formations.

Frank (10) comes to a similar conclusion from his own observations, and from a discussion of the papers of Krick, Sorauer, and earlier authors.

Under Kuster's (19) arrangement of plant pathology *Hevea* nodules would come under Hyperplasie, sub-section Heteroplastic Tissue, and would be classed near wound wood as "tissue resembling wound wood," included in which section are nodules of beech, pear, and apple. This classification is not quite satisfactory, as the structures described as "tissue resembling wound wood" appear sufficiently distinct to merit a more detailed definition.

The presence of globular shoots in *Hevea brasiliensis* can be fully accounted for within the normal life of the plant. "Every plant-body forms more primordia of organs than it is able to bring to maturity. Just as by far the greater number of seeds which are annually formed are destroyed, sometimes because they do not find favourable environment for their development, sometimes because they are overcome by other organisms in their 'struggle for existence,' so also some of the primordia of organs remain undeveloped because the plastic material which they require for their unfolding is taken by others which exercise a stronger attraction upon it" (Goebel, p. 207). Thus, of the buds laid down in a leaf axil one develops into a shoot, while its correlation with the other buds in the leaf axil results in their suffering arrest in development. That these arrested buds remain capable of development is seen in the abundant production of new shoots from old stems under suitable change of conditions; consequently

these buds experience only temporary retardation. At a later date they may begin a slow process of growth, but having lost their connection with the stem and receiving an inadequate supply of food material, they are unable to develop normally, and thus globular shoots are produced.

The case of nodules is somewhat different, and here we undoubtedly have a new formation. The production of these nodular bodies is induced by a definite determining cause, namely, the alteration in the latex vessel content, where under normal conditions they would not be produced. As this alteration in the latex vessel content advances along the latex vessels, it is accompanied by the laying down of nodular wood round the latex vessels; this is illustrated in the flat plate-like nodules of net structure with projecting points at the top and bottom ends.

In tapping operations on estates numerous opportunities occur for the transference of this abnormal nodular condition, if it is transferable, from affected trees to non-affected trees. From the small number of trees affected it must be concluded that it is not transferable, but rather that affected trees have a predisposition to alteration in the latex vessel content. This would affect estate practice, in that great care should be taken to select seed for planting from trees free from nodules, as recommended by Petch in 1906.

The question arises as to whether the alteration in the latex vessel content is brought about by external causes or by unknown internal influences; it must be admitted that this point is still obscure. The evidence, however, lends support to the view that wounding (*e.g.*, tapping) has some effect in inducing the alteration in the latex vessel content in trees which are predisposed to this condition. In support of this view we have the fact that out of a large number of untapped trees systematically examined not one showed development of nodules, though this number includes trees up to eleven years of age. Out of 2,000 untapped trees eleven years old, six yielded nodular structures of about the size of a pea. Microscopic examination showed in four trees, where the structures were obtained from wound callus, that the structures were built up round cavities filled with coagulated latex.

Thus, in the absence of altered latex vessels in the core, these are not typical nodules, nor are they to be classed with nodules. In two trees structures were obtained which showed the central core to be composed of portions of cortical tissue without latex vessels, and thus these differ still more widely from typical nodules. These latter were obtained from the cortex where the bark had no special markings externally.

It would appear therefore that *Hevea* cortex is capable of developing woody bodies as the result of various disturbances in the cortex.

In the production of vascular connections with the stem nodules may exhibit a sort of polarity, as in the production of vascular connections by globular shoots on their inner surface. Some of the vascular connections of nodules may be derived from latent buds or globular shoots which have been caught up and absorbed by the nodule in its development.

There still remains to be determined the nature and cause of the alteration in the latex vessel content, and any advance in this direction will depend on advance in our knowledge of the constitution of latex and its function in the internal economy of *Hevea brasiliensis*.

SUMMARY.

1. Nodules are produced in the cortex of *Hevea brasiliensis* as the result of an alteration in the latex vessel content.

2. This alteration has not been connected with the attack of any parasitic organism, but appears rather to be due to physiological changes in the latex.

3. The tendency to suffer alteration in the latex vessel content appears to be confined to certain individual trees which have a predisposition to develop this condition.

4. Four types of nodule have been distinguished :—

(a) Nodules formed round altered latex vessels.

(b) Nodules formed round lesions in the cortex into which latex has oozed and coagulated. May occur in any *Hevea* tree.

- (c) Nodules formed round areas into which latex has oozed and coagulated; the coagulated latex occupies the intercellular spaces without lesion of tissue. May occur in any *Hevea* tree.
- (d) Nodules formed under unknown conditions round areas of cortex from which latex may be entirely absent. Rare.

5. Globular shoots formed by the subsequent growth of latent buds after these have lost their connection with the stem occur in both tapped and untapped trees. They are distinguished from nodules by the absence of a core, and never form large masses of woody tissue as nodules do.

6. Nodules do not occur on untapped trees.

7. Nodules occur on *Hevea* in its native habitat in Brazil, and in Tropical America and the Eastern Tropics where it has been grown in plantations.

8. The percentage of trees which develop nodules is very small.

9. Tapping appears to induce nodule formation in pre-disposed trees.

10. This abnormal condition is apparently not infectious.

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Early Ceylon Seed Lists.

BY

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THE systematic study of Ceylon botany may be said to have been begun during the Dutch occupation, and the earliest work is based on the collections of Paul Hermann, who was in Ceylon during 1672-79 and collected plants, chiefly in the neighbourhood of Colombo. The catalogue of Hermann's collection was published after his death by W. Sherard, in 1717, under the title of "*Musæum Zeylanicum*," and his specimens subsequently came into the hands of Linnæus, who published a full description of them under the title of "*Flora Zeylanica*."

Hermann is supposed to have also collected many fruits and seeds, which remained in the Leyden collection, and were not seen by Linnæus or included in his "*Flora Zeylanica*." Many of these were subsequently named and described by Gærtner in his "*De Fructibus et Seminibus Plantarum*" (1789-91), a work which consists of an extensive series of drawings of seeds and fruits from all the then-known parts of the world.

It is possible, however, that the Leyden collection received additions in other ways. In the course of the exchange of seeds and plants between the different Dutch possessions, or in the exploitation of their natural resources, many seeds and fruits of possible economic value, or remarkable for their peculiar form, would reach Holland, and some of these would no doubt find their way into museums and botanical collections.

Direct evidence of the exportation of collections of seeds from Ceylon to Holland is provided by two lists, now in the files of the Royal Botanic Gardens, Peradeniya, dated 1762 and 1785, respectively. The first is a list of one hundred packets of medicinal seeds sent to the Chamber of Delft; the second, a similar list of one hundred and fifty packets of medicinal seeds sent to the Botanic Garden at Leyden. The

two lists bear the same signature, "Bt. Aleman." They were originally in the Record Office.

The lists give the native names of the seeds sent. In general, these names are in use at the present day, and the lists therefore are of interest, in that they provide evidence of the persistence of certain names, though we have, of course, no evidence that they now designate the same plant as they did 150 years ago, except in the case of those plants which were collected by Hermann. They are reproduced below, with the addition of the modern form of the name and the scientific name of the plant now known by that name. The inclusion of the modern form of the name in brackets indicates that such is the probable spelling, but no record of any plant bearing that name has been found. When both the modern form of the name and the scientific name are enclosed, the identification has been recorded, but has not been verified by any botanist, as far as has been ascertained. The remaining identifications are taken from Trimen's "Handbook to the Flora of Ceylon."

The spelling is fairly consistent: oe = u and ie = i, unless the e bears a diæresis, when ie = iya. G = h, or may = k.

LIST No. 1.

Catalogus der Ceijlonse Rijpe medicinaale Zaden voor de Camer delft, Bestaande in hondert Sakjes; als

- | | | |
|-----------------|------------------|--|
| 1. Kekkerie | .. Kekiri | .. <i>Cucumis pubescens</i> Willd. |
| 2. Mara | .. Mara | .. <i>Albizzia Lebbek</i> Benth. |
| 3. Kierie gende | .. Kiri henda | .. <i>Celosia argentea</i> L. |
| 4. Siemboela | .. Siyambala | .. <i>Tamarindus indica</i> L. |
| 5. Ankende | .. Ankenda | .. <i>Acronychia laurifolia</i> Bl. |
| 6. Yamanara | .. [? Jamanaran. | <i>Citrus nobilis</i> , Clough, p. 190]. |
| 7. Piene | .. [Pinna | .. <i>Clerodendron infortunatum</i> L., Clough, p. 353]. |
| 8. Demote | .. Demata | .. <i>Gmelina asiatica</i> L. |
| 9. Moeroenga | .. Murunga | .. <i>Moringa pterygosperma</i> Gært. ? |

10.	Annona	.. [Anona	.. <i>Anona squamosa</i> L., Clough, p. 34].
11.	Kiene	.. Kina	.. <i>Calophyllum tomentosum</i> Wight.
12.	Pota	.. Pota-wel	.. <i>Pothos scandens</i> L.
13.	Areloe	.. Aralu	.. <i>Terminalia Chebula</i> Retz.
14.	Yanbole	.. Jambola	.. <i>Citrus decumana</i> Murr.
15.	Talle	.. Tel-tala	.. <i>Sesamum indicum</i> L.
16.	Abbe	.. Aba	.. <i>Brassica juncea</i> HK. f. & Th.
17.	Giendam	.. Hindan	.. <i>Eugenia corymbosa</i> Lam.
18.	Tarenne	.. Tarana	.. <i>Webera corymbosa</i> Willd.
19.	Baloe	.. ? Bala	.. <i>Nothopegia Colebrookiana</i> Bl.
20.	Kodoe meries	.. Kudu miris	.. <i>Toddalia aculeata</i> Juss.
21.	Kook motte	.. Kokmota	.. <i>Eriocaulon sexangulare</i> L.
22.	Kerreu	.. Karawu	.. <i>Phyllanthus indicus</i> Muell.-Arg.
23.	Aukedie	.. —	.. —
24.	Ran motte	.. Ranmotu	.. <i>Xyris indica</i> L.
25.	Kabelose	.. Kabarasa	.. <i>Smilax zeylanica</i> L.
26.	Midile	.. Ela-midella	.. <i>Barringtonia acutangula</i> Gærtn.
27.	Koeroendoe	.. Kurundu	.. <i>Cinnamomum zeylanicum</i> Bl.
28.	Baloetore	.. [Balu tora]	.. —
29.	Gien madoe	.. Hin madu	.. <i>Ipomœa angustifolia</i> Jacq.
30.	Gasembile	.. Bu embila	.. <i>Antidesma Ghæsembilla</i> Gærtn.
31.	Rato loinde	.. [? Ratu olinda	<i>Abrus precatorius</i> var., Moon, p. 52].
32.	Katoetan palla	.. Katu tampala	<i>Amarantusspinosus</i> L.
33.	Ambe	.. Amba	.. <i>Mangifera indica</i> L.
34.	Rat embela	.. Rat-ambala	.. <i>Ixora coccinea</i> L.
35.	Kieri poes	.. [Kiri pus]	.. —
36.	Radelie	.. Radaliya	.. <i>Connarus monocarpus</i> L.
37.	Baandoera	.. Bandura	.. <i>Nepenthes distillatoria</i> L.
38.	Ille-oliende	.. [Ela olinde	<i>Abrus precatorius</i> var., Clough, p. 85].
39.	Hatawarie	.. Hatawariya	.. <i>Asparagus</i> spp.

40.	Koon	.. Kon	.. <i>Schleichera trijuga</i> Willd.
41.	Yakberie	.. Yakberiya	.. <i>Crotalaria laburnifolia</i> L.
42.	Paluken	.. Palukan	.. <i>Uvaria zeylanica</i> L.
43.	Korekaga	.. Kora kaha	.. <i>Memecylon umbellatum</i> Burm. f.
44.	Maha poes	.. [Maha pus.	.. <i>Entada scandens</i> Benth. Clough, p. 470].
45.	Moore	.. Mora	.. <i>Nephelium longana</i> Camb.
46.	Koekoeroemaan	Kukurumaan	<i>Randia dumetorum</i> Lam.
47.	Kette kalle	.. Ketakala	.. <i>Brideliaretusa</i> Spreng.
48.	Ingoel	.. Hingul	.. <i>Amoora Rohituka</i> W. & A.
49.	Moenemal	.. Munamal	.. <i>Mimusops Elengi</i> L.
50.	Pere	.. Pera	.. <i>Pisidium Guajava</i> L.
51.	Tristewalie	.. Trastawalu	.. <i>Ipomœa Turpethum</i> Br.
52.	Dombe	.. Domba	.. <i>Calophyllum Inophyllum</i> L.
53.	Gienpoes	.. [Hin pus	.. <i>Entada scandens</i> Benth., Clough, p. 373].
54.	Goraeke	.. Goraka	.. <i>Garcinia Cambogia</i> Desrouss.
55.	Kienigieri	.. Kinihiriya	.. <i>Cochlospermum Gosypium</i> DC.
56.	Loenoe midile	.. Lunumidella	.. <i>Melia dubia</i> Cav.
57.	Wellikaga	.. Welikaha	.. <i>Memecylon capitellatum</i> L.
58.	Inginie	.. Ingini	.. <i>Strychnos potatorum</i> L. f.
59.	Boeroele	.. Burulla	.. <i>Leea sambucina</i> Willd.
60.	Nie engela	.. Niyangala	.. <i>Gloriosa superba</i> L.
61.	Pere tambela	.. Pera-tambala	.. <i>Gærtnera Kænigii</i> Wight.
62.	Gientala	.. Hin tala	.. <i>Ocimum canum</i> Sims.
63.	Ma atala	.. [? Maha tala]	—
64.	Hien bowitia	.. Hin bowitiya	.. <i>Osbeckia aspera</i> Bl., Moon, p. 35.
65.	Indie	.. Indi	.. <i>Phœnix zeylanica</i> Trim.
66.	Koemboeroe	.. Kumburu-wel	<i>Cæsalpinia Bonduc</i> Roxb.

- | | | | |
|-----|----------------|---|--|
| 67. | Kana Gorreke | .. Kana Goraka | <i>Garcinia Morella</i> Des-rouss. |
| 68. | Moessenne | .. ? Mussenda | .. <i>Mussaenda frondosa</i> L. |
| 69. | Yakwannasse | .. Yakwanassa | .. <i>Anisomeles ovata</i> Br. |
| 70. | Bomie | .. Bomi | .. <i>Litsea chinensis</i> Lam. |
| 71. | Attene | .. Attana | .. <i>Datura fastuosa</i> L. |
| 72. | Wereloe | .. Weralu | .. <i>Elæocarpus serratus</i> L. |
| 73. | Lieme | .. Lima dehi | .. <i>Citrus Hystrix</i> DC. |
| 74. | Ganpile | .. [Gampila | .. <i>Tephrosia purpurea</i> Pers., Moon, p. 55]. |
| 75. | Irrebadoe | .. Erabadu | .. <i>Erythrina indica</i> Lam. |
| 76. | Ratte neli | .. Rata nelli | .. <i>Phyllanthus longifolius</i> Jacq. |
| 77. | Karrewile | .. Karivila | .. <i>Momordica Charantia</i> L. |
| 78. | Karal Gebbe | .. Gas-karal-heba | <i>Achyranthes aspera</i> L. |
| 79. | Koombe | .. Kohomba | .. <i>Azadirachta indica</i> A. Juss. |
| 80. | Rat koombe | .. Rat kohomba | <i>Indigofera aspalathoides</i> Vahl. |
| 81. | Korre kan | .. Kurakkan | .. <i>Eleusine Coracana</i> Gaertn. |
| 82. | Baloetore | .. [?Belitora—plant not ascertained, Clough, p. 430]. | |
| 83. | Kitoel | .. Kitul | .. <i>Caryota urens</i> L. |
| 84. | Wette geja | .. [Wetakeyiya | .. <i>Pandanus</i> sp., Clough, p. 617]. |
| 85. | Illa indoeroe | .. [Ela endaru | .. <i>Ricinus communis</i> , Moon, p. 65]. |
| 86. | Masa bowitia | .. Maha bowitiya | <i>Melastoma malabathricum</i> L. |
| 87. | Gooij wel | .. Goyi wel | .. <i>Flagellaria indica</i> L. |
| 88. | Boeloe | .. Bulu | .. <i>Terminalia belerica</i> Roxb. |
| 89. | Wal embile | .. Wel embilla | .. <i>Embelia Ribes</i> Burm.f. |
| 90. | Diivi kadoeroe | .. Divi kaduru | .. <i>Tabernaemontana dichotoma</i> Roxb. |
| 91. | Wel Gondele | .. ? Hondala | .. <i>Modecca palmata</i> Lam. |
| 92. | Malla batoe | .. Malabatu | .. <i>Solanum ferox</i> L. |
| 93. | Keppetie | .. Keppitiya | .. <i>Croton aromaticus</i> var. <i>lacciferus</i> Trim. |
| 94. | Geen boetoe | .. Himbutu wel | .. <i>Salacia reticulata</i> Wight. |
| 95. | Tieboetoe | .. Tibbatu | .. <i>Solanum indicum</i> L. |
| 96. | Batoe | .. Batu | .. <i>Solanum</i> spp. |
| 97. | Welkieriende | .. Wel kirindi | .. <i>Rourea santaloides</i> W. & A. |

98. Ratte Inderoe .. Rata Endaru . *Jatropha Curcas* L.
 99. Kaloe Gaberele Kalu Habara-
 liya .. *Maba buxifolia* Pers.
 100. Annoda .. Anoda .. *Abutilon asiaticum* G.
 Don, or *A. indicum*
 G. Don.

Colombo, Den 16 October, A° 1762.

Notes on List No. 1.

6. *Yamanara*.—The suggested interpretation involves the assumption that the final n has been dropped. No other instance of that occurs in the list. Hermann (Mus. Zeyl., p. 63) has “Jakuarra,” probably for Yakinaran.

7. *Piene*.—*Clerodendron infortunatum* is usually known as Gas-pinna (Gas = tree), but Clough has Pinna alone. Hermann (Mus. Zeyl., p. 54) gave “Pinna, *Planta fortunata*,” and “Pinna-kola, *Planta infelix*”; both his specimens were *Clerodendron infortunatum*, according to Burmann. The specific name is derived from Hermann’s description.

10. *Anona*.—Hermann gave the name Anon for *Anona* sp. (Mus. Zeyl., p. 62). It is curious that no other botanist has recorded a native name for *Anona squamosa*.

17. *Giendam*.—Gærtner has dam for dan.

23. *Aukedie*.—This is a puzzle. Kedie is perhaps gediya or ketiya, in which case it may be superfluous, e.g., Gærtner cites Lyan-gheddie, which is usually written Lyan. In that case Aukedie may be Ahu, *Morinda* sp.

25. *Kabelose*.—Hermann (Mus. Zeyl., p. 22) has Kabolossa for *Smilax zeylanica* L.

26. *Midile*.—This should be Mudilla, *Barringtonia speciosa*; but the seeds which Gærtner had under the name Medella were *Barringtonia acutangula*, now given as *Ela-midella*.

28. *Baloctore*.—This occurs again as No. 82. It has not been found elsewhere, unless it is the Belitora listed by Clough (Singh.-Engl. Dictionary) without any scientific name.

30. *Gascembile*.—This is *Antidesma Ghæsembilla* Gærtn., the seeds being in the Leyden collection under the name Ghæsembilla, but the name now accepted for this plant is Bu-embilla.

31. *Rato loinde*.—Olinda is *Abrus precatorius*. No. 38, *Ela olinda*, and 31, *Ratu olinda*, may be varieties of that plant, as stated by Clough and Moon, but they are just as likely to be quite different species. They have not been recorded by any botanist.

35. *Kieri poes.*—Kiri pus was recorded by Hermann (Mus. Zeyl., p. 49) as “*Puswæl lactescens*.” It has not been recorded since, and Hermann’s specimen was not seen by Linnaeus. Hermann described it as “*Phaseolus zeylanicus lactescens fructu fusco splendente figura renum*.” Puswel is *Entada scandens*. Hermann also recorded Hin-pus (Mus. Zeyl., p. 69)—“*Phaseolus indicus alatus fructu fusco orbiculata maximo lobis minoribus*,” which Linnaeus stated was very close to Pus-wel—“*Phaseolus indicus alatus fructu fusco orbiculata maximo lobis latissimis et longissimis*.” No other botanist has recorded these two names, nor has any botanist recorded Maha pus. Maha = great; hin = small; kiri = milk.

38. *Ille-oliende.*—See No. 31.

44. *Maha poes.*—See No. 35.

53. *Gienpoes.*—See No. 35.

63. *Ma atala.*—Four species of *Ocimum* bear the name Tala, with different prefixes, but Maha tala is not one of them. Hermann (p. 21) cites *Ættælaghas* as a variant of *Æhælaghas*, i.e., Ehela, *Cassia Fistula* L., but no Maha Ehela is known.

82. See No. 28.

84. *Wette geja.*—This may be *Watu kaju*, cited by Clough (*loc. cit.*, p. 562) as a variety of *Kaju*, *Anacardium occidentale*. Hermann’s spelling of *Keyiya* is *Kegiya*.

85. *Illa indoeroe.*—Endaru is *Ricinus communis*. Ela = white, or pale. Compare No. 98; Rata = foreign.

LIST No. 2.

Leijst der ondervolgende Ceilonse Midicinaale Zaaden voor de hortus te Leijden, bestaande in 150 Sakjes; als

- | | | | | |
|------------------|----|-------------|----|--|
| 1. Boekettia | .. | Bugetiya | .. | <i>Hugonia Mystax</i> L. |
| 2. Hille bebile | .. | [Ela bevila | .. | <i>Sida</i> sp.] |
| 3. Pienne | .. | Gas pinna | .. | <i>Clerodendron infortu-</i>
<i>natum</i> L. |
| 4. Wal oendoe | .. | [Wal undu | .. | <i>Flemingia semialata</i>
Roxb., Clough, p.
578, <i>ex</i> Moon]. |
| 5. Satsander | .. | Sap-sanda | .. | <i>Aristolochia indica</i> L. |
| 6. Anoda | .. | Anoda | .. | <i>Abutilon asiaticum</i>
G. Don, <i>A. indicum</i>
G. Don. |
| 7. Pattengi | .. | Patangi | .. | <i>Cæsalpinia sappan</i> L. |
| 8. Katoe iemboel | .. | Katu imbul | .. | <i>Bombax malabaricum</i>
DC. |
| 9. Rattembela | .. | Ratambala | .. | <i>Ixora coccinea</i> L. |

- | | | | |
|-----|------------------|------------------|--|
| 10. | Porowe Mara .. | Poruwa-mara | <i>Diospyros insignis</i> Thw. |
| 11. | Magul karende .. | Magul-karanda | <i>Pongamia glabra</i> Vent. |
| 12. | Hienbowitia .. | Hin-bowitiya .. | <i>Osbeckia aspera</i> Bl.
(Moon, p. 35). |
| 13. | Hien talla .. | Hin-tala .. | <i>Ocimum canum</i> Sims. |
| 14. | Ran Motte .. | Ran-motu .. | <i>Xyris indica</i> L. |
| 15. | Kini Girië .. | Kinihiriya .. | <i>Cochlospermum Gossypium</i> DC. |
| 16. | Bolloe .. | Bulu .. | <i>Terminalia belerica</i> Roxb. |
| 17. | Sawidare .. | Sewandara .. | <i>Vetiveria zizanioides</i> Stapf. |
| 18. | Siembela .. | Siyambala .. | <i>Tamarindus indica</i> L. |
| 19. | Pipilië .. | Pepiliya .. | <i>Aporosa latifolia</i> Thw. |
| 20. | Tite kidi .. | Titta kinda .. | <i>Tinospora crispa</i> Miers. |
| 21. | Anona .. | [Anona .. | <i>Anona squamosa</i> L.,
Clough, p. 34]. |
| 22. | Rat korreke .. | Rata goraka .. | <i>Garcinia Xanthochymus</i> Hk. f. |
| 23. | Kekoene .. | Kekuna .. | <i>Canarium zeylanicum</i> Bl. |
| 24. | Patta billi .. | ?Beli patta .. | <i>Hibiscus tiliaceus</i> L. |
| 25. | Lunu .. | Wal-lunu .. | <i>Pancratium zeylanicum</i> L. |
| 26. | Wal tembili .. | ?Wal dambala .. | <i>Dolichos falcatus</i> Klein. |
| 27. | Keppittia .. | Keppitiya .. | <i>Croton aromaticus</i> var. <i>lacciferus</i> Trim. |
| 28. | Yak beria .. | Yak-beriya .. | <i>Crotalaria laburnifolia</i> L. |
| 29. | Bien noege .. | Bin-nuga .. | <i>Tylophora asthmatica</i> W. & A. |
| 30. | Wel keppittia .. | Wel-keppitiya .. | <i>Croton aromaticus</i> L. |
| 31. | Itte Siembela .. | [Et Siyambala] | — |
| 32. | Rat tanne .. | Rat-tana .. | <i>Ischæmum ciliare</i> Retz. |
| 33. | Hie wal tore .. | — .. | — |
| 34. | Moessende .. | Mussenda .. | <i>Mussaenda frondosa</i> L. |
| 35. | Hamparendael .. | Hamparandella .. | <i>Mallotus philippinensis</i> Muell.-Arg.,
Thwaites, p. 273. |
| 36. | Kohou kirile .. | Kohu kirilla .. | <i>Grewia Microcos</i> L. |
| 37. | Hienpoes .. | [Hin pus .. | <i>Entada scandens</i> Benth., Clough, p. 373]. |

- | | | | |
|-----|-----------------------|----------------------|---|
| 38. | Walme | .. Wal me | .. <i>Phaseolus adenanthus</i> Meyer |
| 39. | Oendoe piele | .. Undu piyali | .. <i>Desmodium</i> spp. |
| 40. | Ahouw | .. Ahu | .. <i>Morinda</i> spp. |
| 41. | Pielle | .. Pila | .. <i>Tephrosia purpurea</i> Pers. |
| 42. | Katte roddoe | .. Kata rodu wel | <i>Clitoria ternatea</i> L. |
| 43. | Kottela | .. Kotala wel | .. <i>Torenia asiatica</i> L. |
| 44. | Battoe | .. Batu | .. <i>Solanum</i> sp. |
| 45. | Toetiri | .. Tuttiri | .. <i>Andropogon aciculatus</i> Retz. |
| 46. | Kiri koerakan | .. [Kiri kurakkan | <i>Eleusine Coracana</i> Gært., Moon, p. 9]. |
| 47. | Hampienne | .. Hampinna | .. <i>Flemingia strobilifera</i> Br. |
| 48. | Koedoe miries | .. Kudu miris | .. <i>Toddalia aculeata</i> Pers. |
| 49. | Agge moelle netti wel | .. Aga-mula-neti-wel | .. <i>Cuscuta chinensis</i> L. |
| 50. | Soerië Mara | .. Suriya-mara | .. <i>Albizzia odoratissima</i> Benth. |
| 51. | Naperite | .. Na-piritta | .. <i>Hibiscus furcatus</i> Roxb. |
| 52. | Moene mal | .. Muna mal | .. <i>Mimusops Elengi</i> L. |
| 53. | Niengala | .. Niyangala | .. <i>Gloriosa superba</i> L. |
| 54. | Penni-tore | .. Penitora | .. <i>Cassia occidentalis</i> L. |
| 55. | Ikiri | .. [Ikiri | .. <i>Barleria Prionitis</i> L., Clough, p. 67]. |
| 56. | Ratte kekoene | .. Rata kekuna | .. <i>Canarium commune</i> L., or <i>Aleurites triloba</i> Forst. |
| 57. | Maha bowitia | .. Maha bowitiya | <i>Melastoma malabathricum</i> L. |
| 58. | Hampalenda | .. Han-palanda | .. <i>Terminalia parviflora</i> Thw. |
| 59. | Hie walda | .. — | .. — |
| 60. | Koerakan | .. Kurakkan | .. <i>Eleusine Coracana</i> Gært. |
| 61. | Ratte nilli | .. Rata-nelli | .. <i>Phyllanthus longifolius</i> Jacq. |
| 62. | Eppelle | .. Epala | .. <i>Triumfetta rhomboidea</i> Jacq. |
| 63. | Maddetië | .. Madatiya | .. <i>Adenanthera pavonina</i> L. |
| 64. | Pilile | .. Pilila | .. <i>Loranthus</i> spp., <i>Viscum</i> spp. |

65. Tite koemetië .. ? Kumatiya .. *Allmannia nodiflora* Br.
66. Hondelle .. Hondala .. *Modecca palmata* Lam.
67. Kekeri .. Kekiri .. *Cucumis pubescens* Willd.
68. Hoenoe kirile .. Hunu kirilla .. *Glochidion zeylanicum* A. Juss.
69. Kotte tiemboela Kota dimbula. *Ficus hispida* L. f.
70. Yak irre baddoe Yak-erabadu .. *Erythina ovalifolia* Roxb.
71. Koen koeroe .. — .. —
72. Sammedera .. Samadara .. *Samadara indica* Gærtn.
73. Boerenda .. Gurenda .. *Celtis cinnamomea* Lindl.
74. Koekoeroemaen Kukuruman .. *Randia dumetorum* Lam.
75. Illadan .. [Ela dan, quoted by Moon, without name].
76. Amberella .. Embarella .. *Spondias mangifera* Willd.
77. Ille oliende .. [Ela olinda .. ? *Abrus precatorius* L.,[§] var.].
78. Kal Rattembela [Gal Ratambala .. ? *Ixora* sp.].
79. Ran mannise .. Ran-manissa .. *Cleome viscosa* L.
80. Oliende .. Olinda .. *Abrus precatorius* L.
81. Ille inderoe .. [Ela endaru .. *Ricinus communis* L., Moon, p. 65].
82. Midi .. Midi .. *Premna serratifolia* L.
83. Maha Rattembela Maha-ratambala .. *Ixora parviflora* Vahl.
84. Makoeloe .. Makulu .. *Hydnocarpus venenata* Gærtn.
85. Tarrene .. Tarana .. *Webera corymbosa* Willd.
86. Bien tanboeroe .. Bin tamburu .. *Ipomœa repens* Lam.
87. Siri Weddi Bebile Giri wadi bevilala .. *Sida mysorensis* W. & A.
88. Kokmotte .. Kokmota .. *Eriocaulon sexangulare* L.
89. Attene .. Attana .. *Datura fastuosa* L.
90. Kaveloe .. Kawalu .. *Setaria glauca* Beauv.
91. Pol ambe .. Pol amba .. *Mangifera indica* L., var.
92. Rat inderoe .. Rata endaru .. *Jatropha Curcas* L.

93.	Kappoe	.. Kapu	.. <i>Gossypium herbaceum</i> L.
94.	Iembul	.. Imbul	.. <i>Eriodendron anfractuosum</i> DC.
95.	Wela	.. Wela	.. <i>Gyandropsis pentaphylla</i> DC.
96.	Yapara	.. [Yapura—medicinal plant, not ascertained, Clough, p. 379].	
97.	Dombe	.. Domba	.. <i>Calophyllum Inophyllum</i> L.
98.	Yak wannasse	.. Yak wanassa	.. <i>Anisomeles ovata</i> Br.
99.	Boeroella	.. Burulla	.. <i>Leea sambucina</i> Willd.
100.	Ratte toembe	.. [Rata tumba]	—
101.	Ienkini	.. Ingini	.. <i>Strychnos potatorum</i> L. f.
102.	Kolloe	.. Kollu	.. <i>Dolichos biflorus</i> L.
103.	Ammoe	.. Amu	.. <i>Paspalum scrobiculatum</i> L.
104.	Welli kaha	.. Welikaha	.. <i>Memecylon capitellatum</i> L.
105.	Et pile	.. [Et pila, cited by Moon, without name].	
106.	Kette kolle	.. Keta kala	.. <i>Bridelia retusa</i> Spreng.
107.	Korosse	.. Korasa-wel	.. <i>Delima sarmentosa</i> L.
108.	Wal koloe	.. Wal-kollu	.. <i>Atylosia</i> spp.
109.	Kira ambe	.. [Giri amba	.. <i>Mangifera indica</i> L., var., Clough, p. 161].
110.	Pere	.. Pera	.. <i>Psidium Guajava</i> L.
111.	Maha talla	.. [Maha tala]	.. —
112.	Auweri	.. Awari	.. <i>Indigofera tinctoria</i> L.
113.	Moendoeme	.. [Mudu-me	.. <i>Phaseolus caracalla</i> , Moon, p. 52].
114.	Boomboe	.. Bombu	.. <i>Symplocos spicata</i> Roxb.
115.	Mi	.. Mi	.. <i>Bassia longifolia</i> L.
116.	Agge Moelle netti wel	.. Agamulaneti-wel	.. <i>Cuscuta chinensis</i> Lam.
117.	Godda kaddoeroe	Goda-kaduru	.. <i>Strychnos Nux-vomica</i> L.
118.	Ettemboela	.. —	.. —
119.	Pawata	.. Pawatta	.. <i>Pavetta indica</i> L.
120.	Toede wedia	.. —	.. —
121.	Boepile	.. Bu-pila	.. <i>Tephrosia villosa</i> Pers.
122.	Palloeken	.. Palukan	.. <i>Uvaria zeylanica</i> L.
123.	Irië	.. Iriya	.. <i>Myristica Irya</i> Gærtn.

124. Moedela .. Mudilla .. *Barringtonia speciosa*
Forst.
125. Ratte inderoe .. Rata-endaru .. *Jatropha Curcas* L.
126. Bokere .. Bo-kera .. *Ochna Wightiana*
Wall., or *Gomphia*
angustifolia Vahl.
127. Hanna .. Hana .. *Crotalaria juncea* L.
128. Kine .. Kina .. *Calophyllum tomento-*
sum Wight, or *Calo-*
phyllum Walkeri
Wight.
129. Andene hirië .. Andana hiriya *Crotalaria* spp.
130. Apuu mandoe . [Apasu madu . *Convolvulus triflorus*,
Moon, p. 13].
131. Ille rat nitoel .. Ela-rat-netul . *Plumbago rosea* L.
132. Kal tanne .. [Gal tana] .. —
133. Boel eppelle .. [? Bu Epala, cited by Moon, without
name].
134. Wette kiija .. Wata keyiya .. *Pandanus* sp.
135. Diwi kaddoeroe. Divi-kaduru . *Tabernæmontana di-*
chotoma Roxb.
136. Koemetië .. Kumatiya .. *Allmannia nodiflora*
Br.
137. Maha iendie .. Maha Indi .. *Phoenix sylvestris* L.
138. Bilien .. Bilin .. *Averrhoa Bilimbi* L.
139. Kattoe karendoe Katu karandu *Barleria Prionitis* L.
140. Areloe .. Aralu .. *Terminalia Chebula*
Retz.
141. Wille wel .. ? Wila .. *Bonnaya veronicæ-*
folia Spreng.
142. Pere tambela .. Pera-tambala . *Gærtnera Kænigii*
Wight.
143. Balloe wannasse [Balu wanassa] .. —
144. Ankenda .. Ankenda .. *Acronychia laurifolia*
Bl.
145. Loenoe kinde .. ? Lunu ankenda *Euodia Roxburghi-*
ana Benth.
146. Marri tondi .. Maru tondi .. *Lawsonia alba* Lam.
147. Hel kasambilia . — .. —
148. Rat kohombe .. Rat-kohomba. *Indigofera aspalath-*
oides Vahl.
149. Kiri , .. [Kiri .. *Eleusine Coracana*
Gærtn., Clough, p.
120].
150. Werelle .. Eta-werelle .. *Dodonæa viscosa* L.

Kolombo, Den 29 January A° 1785.

Notes on List No. 2.

2. *Hille bebile*.—Probably *Ela bevila*, but that name is not on record. *Bevila* is a generic term for *Sida*.

3. *Pienne*.—See List 1, No. 7.

4. *Wal undu*.—Hermann (Mus. Zeyl., p. 67) recorded Walundughala, “*Est arbor trifoliata*,” but his specimen was not seen by Linnæus. Walundu was given by Moon for *Flemingia alata*, now *Flemingia congesta*, var. *alata*, but the name has not been recorded since.

24. *Patta billi*.—An alternative is *Patta walla*, *Gylinops Walla*. Compare the use of Beligam for Weligama.

25. *Lunu*.—This is a general term, with prefixes, for onions, garlic, &c., but that can scarcely be the correct interpretation in this case. Hermann (Mus. Zeyl., p. 61) has “*Wallunu*, *Lunala*, *Luna*. *Narcissus zeylanicus* flore albo hexagono major bulbo rotundo.” This is *Pancratium zeylanicum* L., Wal-lunu.

26. *Wal tembili*.—Tembili is one of the names of the coconut, and Tembiliya is *Eugenia bracteata* Roxb. Wal tembili has not been recorded.

31. *Itte Siembela*.—Siyambala is *Tamarindus indica*. Et = great. Et-siyambala is not known.

33. *Hie wal tore*.—The first syllable probably represents Si or Gi. Compare No. 59. Tora is a general name for *Cassia* spp.

35. *Hamparendael*.—This is usually written Hamaparanda, but Thwaites, Enumeratio, p. 273, has Hamparandella.

37. See List 1, No. 35.

46. *Kiri koerakan*.—Kurakkan is *Eleusine Coracana*; kiri = milk. The combination Kiri kurakkan is given by Moon.

55. *Ikiri*.—This appears in old lists without a prefix. Katu-ikiri is *Hygrophila spinosa* And.; the usual name for *Barleria Prionitis* is Katu-karandu.

59. *Hie walda*.—Compare No. 33. Da may be Dan, *Eugenia* sp., or *Ardisia*.

66. Gärtner noted that in the Leyden collection several different kinds of Ceylon seeds were labelled Hondala.

71. *Koen koeroe*.—Hermann (Mus. Zeyl., p. 57) has “*Kon-ghuru*. Kine major. Hæc arbor fert fructus magnitudine nucis Juglandis nucleo valde oleoso. Nux zeylanica oleosa major”; it is not included in *Flora Zeylanica*. Or may Kunkuru be an error for Kumburu, *Cæsalpinia Bonduc* Roxb.?

73. *Boerenda*.—Moon stated that Booraenda = Gooraenda. The seeds which Gärtner had under the name Burende were *Clerodendron inerme*, now known as Wal Gurenda.

75. *Illadan*.—This should be a species of *Eugenia* or *Ardisia*. The name has not been recorded except by Moon (Ela dan), and he did not give any identification.

77. *Illa oliende*.—See List 1, No. 38.

78. *Kal Rattembela*.—Gal = rock. Ratambala is *Ixora coccinea* L.

81. *Ille inderoe*.—See List 1, No. 85.

96. *Yapara*.—Yapura is given by Clough (p. 379) as a medicinal plant; not ascertained. Hermann (Mus. Zeyl., p. 24) recorded "Sabara. Sagittariæ species, flores fert ex medio caulis," and Linnæus (Fl. Zeyl., p. 54) identified this with Diya-habarala, *Monochoria hastafolia*. The same name, in the form Yabara, has been applied to the recently-introduced Water Hyacinth, which in the Southern Province has received the name Japan Yabara, it having been introduced from Hong Kong. It is probable, therefore, that Yapara was *Monochoria*, either *M. hastafolia* or *M. vaginalis*.

100. *Ratte toembe*.—Rata tumba. Tumba is a general name for *Leucas*, but Rata tumba is not known.

105. *Et pile*.—Et pila is known only from Moon, and he did not identify the plant.

111. *Maha talla*.—Compare No. 63 in List 1.

113. *Moendoeme*.—Mundu-me. Hermann (Mus. Zeyl., p. 54) recorded "Mundu-mæ, *Phaseolus zeylanicus marinus* crassus, an flos Thomeus?" Linnæus did not see Hermann's specimen. Moon recorded the same name in the form Mudume, and referred it to *Phaseolus caracalla*. But what he meant by the latter name is not known. Trimen (Flora of Ceylon, II., p. 70) suggested that Moon's plant might be *Phaseolus adenanthus* Meyer, but this does not agree with Moon and Hermann, both of whom, apparently, refer to a sea coast plant. Mudu = sea. The accepted native name of *Phaseolus adenanthus* is Wal-me (No. 38 in this list); this is probably Hermann's Wal-limæ (Mus. Zeyl., p. 44), "*Phaseolus Zeylanicus tenellus siliquis angustis*."

118. *Ettemboela*.—Clough (p. 94) cites Embula, as a variety of *Nymphæa*, evidently for Ambala, *Limnanthemum*. Et-embula is not known.

120. *Toede wedia*.—Tudu wediya. The nearest approach to this name is Udu-wediya (Udhawaedhiya), given by Hermann (Mus. Zeyl., p. 20) for *Loranthus loniceroides* L.

130. *Apuu mandoe*.—Apasu madu, cited by Moon, is evidently the same name (Apuhu = apusu = apasu). Moon identified it as *Convolvulus triflorus*, but there is nothing to show what he meant by that. Madu (Mandu) is a general term for *Ipomœa*. Hermann (Mus. Zeyl., p. 39) gave "Apas. Apathuætha. *Convolvulus zeylanicus gracilis tenuifolius*"

(etta = seeds), and (*loc. cit.*, p. 43) "Apahu. *Convolvulus indicus* Cantabricæ folio latiori, floribus albis. *Phaseolus silvaticus paludosus*." These were not named by Linnæus in *Flora Zeyl.* Trimen quotes Hermann, p. 39, for *Ipomæa tridentata* Roth., but does not mention Apahu.

132. *Kal tanne*.—Gal = rock; and Tana is a common constituent of names of grasses, but Gal-tana is not on record.

133. *Boel eppelle*.—Bul epala is not known. Epala is *Triumfetta rhomboidea* Jacq.

143. *Baloe wannasse*.—This name was recorded by Hermann (*Mus. Zeyl.*, p. 25) as Balu wanossa, but no description was given, and the specimen was not seen by Linnæus. It has not been recorded since.

147. *Hel kasambilia*.—Hel kahambiliya is cited by Clough, p. 747, without identification. Kahambiliya is a general term for any irritating plant, *e.g.*, Gas-kahambiliya = *Girardinia heterophylla* Dene., and Wal-kahambiliya = *Fleurya interrupta* Gaud.

150. *Werelle*.—Hermann (*Mus. Zeyl.*, p. 32) recorded this name as Wærelle ghas. It is *Dodonæa viscosa* L., Eta-werella.

Revisions of Ceylon Fungi.

(PART V.)

BY

T. PETCH, B.A., B.Sc.

138.—*Lepiota alborussea* B. & Br.

PILEUS up to 5 cm. diameter, almost plane, depressed or obtusely umbonate, sometimes with a depression in the umbo, deep reddish-purple in the centre, elsewhere radially streaked with reddish-purple, sometimes broken into minute scales. Flesh white, turning reddish under the cuticle when cut. Stalk up to 5 cm. high, 5 mm. diameter in the middle, inflated at the base, attenuated upwards, usually curved below, white, shining, stuffed, then hollow. Ring ascending, white, edge slightly coloured. Gills free, white, rather crowded, subventricose, rounded at both ends. Spores white, oval, somewhat pointed at the distal end, $7-9 \times 3-4 \mu$.

In flower beds, Peradeniya.

139.—*Lepiota erythrogramma* B. & Br.

Under this name Berkeley and Broome placed four of Thwaites's figures, dividing them into the species and two varieties. Figure 1202 was named *Lepiota erythrogramma*, figure 1187, var. b, and two figures, both numbered 1159, var. c.

Figure 1202, the type of *Lepiota erythrogramma*, does not differ from *Lepiota alborussea*. Berkeley and Broome apparently noted the resemblance, for they stated that *L. alborussea* differed in the breadth of its spores. As the specimens are not in Herb. Peradeniya, I am unable to test that statement, but the character does not appear to be one on which to found a species. I find the spores of *L. erythrogramma* var. b, $6-7 \times 3 \mu$, and those of *L. alborussea*, $7-9 \times 3-4 \mu$.

Variety c appears to be identical with *Lepiota carpophylla* B. & Br. Here, again, Berkeley and Broome noted the resemblance, and stated that the latter differed from all forms of *L. erythrogramma* in the different nature of the ring. In both species the ring is movable; in *L. erythrogramma* it is usually

upwardly directed, and is so depicted in the figures, but in *L. carpophylla* it was said to be descending. The point is not clear on the figure, but it is certainly not a "descending" ring in the usual sense, *i.e.*, in which the tissue of the ring is continuous with the outer layer of the stalk apex. *L. erythrogramma* var. c appears to me to be *L. carpophylla*, but whether it is more than a stouter form of var. b is questionable.

Lepiota erythrogramma var. b has a pileus at first conico-campanulate, then almost plane, depressed in the centre, or obtusely umbonate, up to 5 cm. diameter, brick-red in the centre, smooth or furfuraceous, elsewhere split into minute brick-red scales or radiating fibrillose streaks. Flesh white, thin, turning red over the stalk when cut. Young unexpanded specimens may be uniformly brick-red. Stalk up to 5 cm. high, 4 mm. diameter in the centre, equal or attenuated upwards, slightly inflated at the base, white, shining, hollow. Ring upwardly directed, submovable, upper edge coloured red. Gills moderately crowded, free, rounded at both ends, white or faintly cream-coloured. Spores white or pale yellow, oval, $6-7 \times 3 \mu$.

140.—*Lepiota euconiata* B. & Br.

Pileus up to 8 cm. diameter, broadly conico-convex or plane, densely covered with loose woolly flocci and meal, purple in the centre, pale violet or pale lilac elsewhere. Pileus (beneath the outer covering) purple in the centre, elsewhere white minutely streaked with purple, margin not striate, slightly appendiculate. Flesh white, spongy, rather thin (4-5 mm.). Stalk up to 8 cm. high, 6-7 mm. diameter below, attenuated upwards, slightly bulbous at the base, rooting clothed with pale lilac meal up to the ring, white and silky striate above, stuffed, then hollow, distinct from the flesh of the pileus; substance of stem translucent towards the exterior, white internally; apex large, contrasting strongly with the flesh of the pileus. Ring ample, fragile, powdered like the stem. Gills white, then pale yellow, free, slightly ventricose, up to 6 mm. broad, rounded at both ends, crowded. Spores white, oval or subglobose, $4-6 \times 3 \mu$.

Among grass, Peradeniya.

141.—*Lepiota spongodes* B. & Br.

Pileus at first hemispherical, then broadly irregularly convex and undulating, centre usually depressed, up to 9 cm. diameter; centre covered with purple-black or dark purple, flat, angular scales with a fibrillose margin, white between, elsewhere covered with shaggy, dark purple, fibrillose scales, silky and reddish-purple between them. Margin at first appendiculate. Flesh white, rather thick, turning reddish when cut. Stalk up to 8 cm. high, 1 cm. diameter, attenuated upwards, usually curved, base slightly bulbous, densely clothed below with reddish-purple woolly flocci, white and silky fibrillose above, hollow. Veil cobwebby, evanescent. Gills crowded, free, narrow (4 mm. broad), white or faintly cream, rounded behind, attenuated outwards. Spores white, oval, $4 \times 3 \mu$.

In many points this species resembles *Lepiota euconiata*, of which it may be only a weather form.

142.—*Lepiota erythrostickta* B. & Br.

Pileus broadly convex, or almost plane, obtusely umbonate, up to 2.2 cm. diameter, bluish-purple or reddish-purple in the centre, even or broken into minute warts, elsewhere white with a purple tinge, with scattered purple, innate, fibrillose scales. Flesh white, turning purplish when cut, rather thick over the stalk. Stalk up to 4 cm. high, 3 mm. diameter, purplish below, clothed with purple fibrillose scales, or points and fibrils, white and silky striate at the apex, equal, base bulbous, hollow, white internally. Ring evanescent or represented by scales only. Gills white or faintly cream-coloured, free, distant, broad, ventricose, rounded at both ends, or rather square behind. Spores white, oblong-oval, slightly narrowed at the distal end, apiculus sublateral, $6-8 \times 3-4 \mu$.

Among dead leaves, Peradeniya.

143.—*Lepiota metulæspora* B. & Br.

Pileus 2.5-4 cm. diameter, broadly campanulate, obtusely umbonate, umbo yellow-brown or reddish-brown, smooth, elsewhere clothed with concentrically arranged, thin, floccose,

pale brown to whitish, adpressed scales and warts, white and silky fibrillose under the scales, sulcate half way to the centre; margin sometimes appendiculate; flesh white, thin. Stalk 6-8.5 cm. high, 3 mm. diameter, slightly swollen at the base, strongly fibrillose with longitudinal white fibrils, yellowish and glabrous when the fibrils are rubbed off, hollow, turning yellow-brown internally when cut, lined with shining white fibrils. Gills white, free, ventricose, broad, rounded at both ends. Spores white, 2 to 6 guttulate, fusiform, ends pointed, or sigmoid on one side, $15-18 \times 6-7 \mu$.

Among dead leaves, Peradeniya.

The figure in Cooke's illustrations, pl. 39, represents a different species.

144.—*Lepiota revelata* B. & Br.

Pileus up to 4 cm. diameter, conico-convex, then repand, obscurely umbonate, with a viscid cuticle continuous over the centre, elsewhere splitting and exposing the white or cream-coloured flesh, dark chestnut in the centre, becoming paler outwards. Flesh very thin over the gills, margin appearing striate when moist. Stalk up to 4 cm. high, 3 mm. diameter, slightly attenuated upwards, bulbous at the base, white becoming pinkish, clothed below with minute scales coloured as the pileus, silky fibrillose above, stuffed, then hollow, cavity comparatively narrow. Gills white, then cream-coloured, free, ventricose. Spores white, oval, or oblong-oval, $4 \times 3 \mu$.

Lepiota rhacoderma B. & Br. appears to be the same species, but the figure shows a solid stalk.

145.—*Lepiota flavido-rufa* B. & Br.

Pileus at first conical, often flattened at the apex, then hemispherical or broadly convex, up to 2 cm. diameter, dull green, blackish-green, olive, or dingy yellow in the centre, elsewhere yellow covered with minute warts and scales of the same colour as the centre; margin appendiculate with yellow flocci; flesh rather thick over the stalk, turning red when cut. Stalk up to 5.5 cm. long, 3 mm. diameter, yellow, mealy with yellow granules and flocci, hollow, lined with white fibrils;

ring evanescent. Gills deep cream-coloured, then pale brown, free, crowded, rounded behind, attenuated outwards, slightly ventricose. Spores oval, $4 \times 2.5-3 \mu$.

On bare ground, gregarious, often in large patches, Peradeniya.

The spores of this species exhibit an extraordinary variability in colour, as will be evident from the following records from different collections:—(1) Spores in mass dark slate-coloured, some yellow; by transmitted light greenish-yellow, with a dark epispore. (2) Spores shed on a glass plate in contact with the pileus varied from yellow, ochraceous, slate-coloured, to blackish from the same pileus; those deposited on the top of other pilei were brown or blackish in mass; others deposited on paper, from pilei supported on pins clear of the paper, were dark slate in mass, with in some places a faint purple tinge; in all cases the spores were greenish-yellow by transmitted light, with a dark line marking the epispore in the case of the dark spores. (3) Another record, from old specimens, is "spores pale purple-brown in mass, almost hyaline by transmitted light." (4) In two cases the spores in contact with the decaying gills were yellow-brown by transmitted light. (5) Another record gives the spore-print greenish-olive to purple-brown when moist, pale yellow to slate-coloured when dry; spores pale yellow or almost hyaline by transmitted light, but yellow-brown if taken from the decaying gills.

We leave this species under Berkeley and Broome's earliest name, though it might be preferable to include it under *Psalliota*. Other names for the same species in the Fungi of Ceylon are *Lepiota hemichlora* B. & Br., *Psalliota subcitrina* B. & Br., *Psalliota myriosticta* B. & Br., and *Psalliota epipasta* B. & Br.

146.—*Omphalia holochlora* B. & Br.

Pileus greenish-yellow, radially streaked with innate, black-brown fibrils, up to 2.5 cm. diameter, at first campanulate, umbilicate, then infundibuliform, margin thin, becoming orange-red in drying, reddish when bruised. Stalk up to 1.5 cm. high, 2 mm. diameter, expanding slightly upwards, dark brown at the base, shading into yellowish-green at the

apex, faintly longitudinally striate, powdered with black granules, hollow, flesh-coloured as externally, lined with a few white fibrils, base tomentose. Gills greenish-yellow, distant, up to 4 mm. broad, decurrent, terminating in a definite line round the stem, sometimes forked, rather fleshy, but with a thin edge, interstices sometimes feebly veined. Spores white, oval, somewhat inequilateral, $8-11 \times 4-5 \mu$.

On dead twigs, &c., Peradeniya.

147.—*Tricholoma rhacophorum* B. & Br.

The painting from which Berkeley and Broome described this species shows a specimen with a dark brown pileus and a slightly scaly stem. I have not met with that form, but the following, which occurred in abundance in November, 1914, agrees with *Tricholoma rhacophorum* in its excentric stalk and echinulate spores, and is probably a variety.

Pileus up to 10 cm. diameter, convex, even or obtusely umbonate, somewhat irregular in outline, white or ochraceous, glabrous or innately hoary, here and there shining. Flesh white, rather thick. Stalk expanding into the pileus, central, or excentric, sometimes almost lateral, up to 4 cm. high, 1 cm. diameter, equal, sometimes bulbous at the base, minutely longitudinally fibrillose. Gills crowded, narrow, arcuate, sinuato-decurrent, white or faintly cream. Spores white, broadly oval or subglobose, $5-6 \times 3.5-4 \mu$, minutely echinulate.

On the ground, from masses of mycelium permeating dead leaves, Peradeniya.

148.—*Collybia crocoba* (B. & Br.).

Fasciculate, connate at the base. Pileus up to 7.5 cm. diameter, broadly convex, undulating, reddish-yellow in the centre, elsewhere yellow, sometimes with radial red streaks, margin reddish-yellow when sodden, minutely scurfy. Flesh yellow, thin, except over the stalk. Stalk up to 10 cm. high, 1 cm. diameter, sometimes inflated and fistulose in the lower half, stuffed, then hollow, pale yellow, sometimes with reddish

streaks, longitudinally innately fibrillose, pruinose at the apex ; base clothed with yellow tomentum. Gills yellow, narrow, crowded, attenuated outwards, rounded behind, adnate. Spores white, globose, 4-6 μ diameter.

At the base of bamboo clumps, Peradeniya, August, 1912.

Described by Berkeley and Broome as *Clitocybe crocophaga*. The original painting shows specimens with an umbonate pileus, as described by Berkeley and Broome, but not decurrent gills.

149.—*Collybia verticolor* B. & Br.

Pileus up to 2 cm. diameter, broadly convex, sometimes with an obtuse excentric umbo, white, subtranslucent, then pallid yellow, glabrous, cartilaginous, margin at first incurved. Stalk usually excentric, the same colour as the pileus, up to 2 cm. high, 2 mm. diameter, equal, expanding into the pileus, glabrous, cartilaginous externally, internally stuffed white, then hollow, strigose at the base, attached to the wood by a patch of radiating hyphæ. Gills the same colour as the pileus, moderately crowded, decurrent, lower edge straight, then suddenly decurrent.

On dead wood, Peradeniya.

150.—*Pluteus balanatus* B. & Br.

Pileus campanulate, 1 cm. diameter, white, diaphanous, membranous, sulcato-striate almost to the centre, glabrous. Stalk up to 2 cm. high, 1 mm. diameter, white, diaphanous, glabrous, longitudinally striate, solid. Gills distant, hyaline, ventricose, broad, free, but close to the stem. Spores broadly oval, 7-8 $\times$ 5-6 μ , or globose 7 μ diameter. Cystidia few, flask-shaped, attenuated below, neck short, 24 $\times$ 8 μ .

On the ground, Peradeniya ; the co-type in Herb. Peradeniya is immature.

151.—*Pluteus eugraptus* B. & Br.

Pileus up to 3 cm. diameter, plane, with a strongly developed obtuse umbo, tawny, centre paler yellow-brown, striate almost to the umbo. Flesh thin. Stalk up to 2 cm. high, 2-3 mm. diameter, expanding upwards, glabrous, yellow-brown, white

internally, stuffed, base slightly tomentose with white tomentum. Gills pink, ventricose, broad (4 mm.), rather distant, free. Spores pink, narrow-oval, $7-9 \times 4 \mu$.

On wood, Peradeniya.

152.—*Pluteus glyphidatus* B. & Br.

Pileus campanulate, obtuse, then expanded, umbonate, up to 5 cm. diameter, lemon-yellow, thickly covered with minute ashy, or gray, close-set warts or points, or streaked with ashy fibrils, centre remaining yellow, the remainder becoming pinkish; margin striate; flesh thin, white. Stalk up to 6 cm. high, 4 mm. diameter, pale yellow or white, equal or slightly attenuated upwards, glabrous, sometimes powdered, tomentose at the base, solid. Gills yellowish, then pink, free, distant, edge minutely serrate, broadly ventricose or equal, rounded at both ends. Spores Indian red in mass, globose, $5-7 \mu$ diameter.

On decaying palm fronds, Peradeniya. A form occurs without any trace of yellow.

153.—*Pluteus escharites* B. & Br.

Pileus up to 3.5 cm. diameter, centre depressed, black-brown in the centre, the cuticle elsewhere broken into minute black-brown scales, arranged somewhat radially, so that the pileus is feebly radially streaked. Ground colour between the scales pallid, then pinkish. Stalk white or pallid, sub-translucent, up to 3.5 cm. high, 3 mm. diameter, equal or slightly expanded upwards, stuffed, then hollow, glabrous above, with a few fibrils below, which turn blackish when handled, or mealy with minute black granules, base slightly white tomentose, often swollen. Gills free, ventricose, rounded at both ends, white, then pink. Spores globose, $5-7 \mu$, or broadly oval, $5 \times 7 \mu$, pink, smooth. Cystidia flask-shaped, up to 20μ high, 16μ diameter below, 6μ above, scanty.

Massée (Grevillea, XXI., pp. 77-82) states that the spores are elliptic fusiform, very minutely warted, $10 \times 6 \mu$, and that cystidia are absent. The co-type in Herb. Peradeniya has globose spores $5-7 \mu$, and flask-shaped cystidia on the

edge of the gills. The figure of *Pluteus stigmatophorus* resembles this species, but shows a solid stalk; there is no specimen in Herb. Peradeniya.

154.—*Entoloma rhodopolium* Fr.

The species recorded by Berkeley and Broome in Fungi of Ceylon, No. 185, as *Entoloma rhodopolium*, has been collected on several occasions at Peradeniya, where it grows among grass, often in large numbers.

The pileus is up to 16 cm. in diameter, at first broadly campanulate, depressed in the centre, then expanded and infundibuliform with a decurved margin, gray-brown, radially streaked with dark innate fibrils, viscid when moist, glabrous and shining when dry, margin feebly striate, strongly striate when dry. Flesh white, thin. Stalk up to 10 cm. high, 1.6 cm. diameter in the middle, attenuated upwards, pallid, then grayish-brown, often twisted, sometimes longitudinally striate, glabrous, powdered at the apex, solid or stuffed, outer layer cartilaginous. Gills sinuato-adsynous, ventricose, margin irregular, pallid, then pink, usually strongly ridged and veined. Spores deep pink, angular, quadrate or pentagonal in plan, $7-11 \times 6-9 \mu$. Cystidia not found.

It is never umbonate, and is clearly not *Entoloma rhodopolium*. It may be known as *Entoloma infundibuliforme*.

***Entoloma infundibuliforme*.—**Pileo ad 16 cm. diam., primo late campanulato, centro depresso, deinde infundibuliformi, margine decurvo, griseo-brunneo, radiatim fibrillis innatis fuscis lineato, udo viscido, sicco glabro nitente, margine leniter striato, valde striato sicco; carne tenui, alba. Stipite ad 10 cm. long., 1.6 cm. diam., sursum attenuato, pallido, deinde griseo-brunneo, sæpe torto, interdum longitudinaliter striato, glabro, apice farinoso, solido vel farcto, exteriore cartilagineo. Lamellis sinuato-adsynous, ventricosus, margine irregulari, pallidis, deinde roseis, valde venosis. Sporibus angulatis, $7-11 \times 6-9 \mu$.

155.—*Entoloma stylophorum* B. & Br.

From Thwaites's figures of this species it might be thought that the peculiar cylindrical umbo was an abnormality.

Recent collections show that this form is of frequent occurrence, though not constant, many specimens having merely a well-developed conical umbo.

The pileus is broadly conico-campanulate, up to 2 cm. diameter, pinkish-white, subdiaphanous, feebly silky-striate, with a well-developed, conical, obtuse umbo, sometimes prolonged into a cylindrical or horn-like outgrowth, up to 2·5 mm. high and 2 mm. diameter. Gills pallid, then pale pink, broad, ventricose, adnate with a decurrent tooth. Stalk up to 3·5 cm. high, 2 mm. diameter, white, subtranslucent, glabrous, shining, equal, slightly inflated at the base, almost solid, with a very narrow central cavity. Spores pink, irregularly nodular, polygonal in outline, $12 \times 9 \mu$.

On the ground, among grass, Peradeniya.

156.—*Eccilia hyalodepas* B. & Br.

Pileus up to 4 cm. diameter, centre depressed or umbilicate, elsewhere plane, margin decurved, ivory white, pellucid, becoming delicately pink, glabrous; flesh thin, translucent. Stalk up to 3 cm. high, 3·5 mm. diameter, equal, or slightly thickened upwards, white, pellucid, minutely pruinose, base tomentose, stuffed, then hollow, cartilaginous. Gills adnato-decurrent, or sinuato-adnate, slightly arcuate, up to 5 mm. broad. Spores pink, angular, 8–10 μ diameter, quadrangular or pentagonal in plan.

157.—*Omphalia peri* B. & Br.

Pileus up to 1 cm. diameter, convex, then plane, finally depressed or infundibuliform, margin at first incurved, usually undulating when full grown, minutely tomentose, white; flesh thin. Stalk short, about 2 mm. high, 1 mm. diameter, equal, or thickened at the base, minutely tomentose. Gills white, then pinkish, not crowded, comparatively broad (1·5 mm.), adnato-decurrent. Spores salmon-pink in mass, oval, $5-8 \times 3-4 \mu$.

This is a *Clitopilus*, and will stand as *Clitopilus peri* (B. & Br.). Thwaites's figure shows a longer stalk, and more crowded, narrower gills.

158.—*Galera zeylanica* n. sp.

Thwaites's figure, No. 711, represents a common Ceylon *Galera*. It was first assigned by Berkeley and Broome to *Galera tenera*, but they afterwards referred it to *Galera lateritia* Fr., under which name it was included in the Fungi of Ceylon. Both names appear on the original painting. It occurs either on the ground, or on dead wood or decaying vegetable refuse, and is probably the *Galera siliginea* Fr. identified by Berkeley among the fungi sent by Gardner. It does not resemble *Galera lateritia*, or *Galera siliginea*; in some respects it is near *Galera tenera*, from which it differs in its white stalk, bulbous at the base.

Pileus conico-campanulate or conico-convex, 1–5 cm. diameter, red-brown in the centre, yellow-brown towards the margin; margin striate, sometimes crenate; flesh thin, brown; fragile. Stalk 4–15 cm. high, 1–5 mm. diameter, white, becoming brownish, attenuated upwards, bulbous at the base, longitudinally striate, sparsely fibrillose, hollow. Gills pallid, then pale brown, rather distant, sometimes ventricose, usually narrow, outer ends rounded, attenuated behind, shortly adnate. Spores oval, brown in mass, yellow-brown by transmitted light, $8-14 \times 4-8 \mu$.

Measurements of the spores of different gatherings give $10-13 \times 6-8 \mu$; $11-14 \times 7-8 \mu$; $8-10 \times 5-6 \mu$; $8-10 \times 4-5 \mu$. When developed under a bell glass, the stalk and pileus are covered with minute erect white hairs, which collapse when the bell glass is removed.

Galera zeylanica.—Pileo conico-campanulato vel conico-convexo, 1–5 cm. diam., centro rubro-brunneo, ad marginem flavo-brunneo; margine striato, interdum crenato; carne tenui, brunneo; fragili. Stipite 4–15 cm. long., 1–5 mm. diam., albo, deinde brunneo, sursum attenuato, basi bulboso, longitudinaliter striato, sparse fibrilloso, cavo. Lamellis pallidis, deinde pallide-brunneis, remotiusculis, interdum ventricosis, sæpius angustis, extus rotundatis, post attenuatis, breviter adnatis. Sporis ovalibus, flavo-brunneis, $8-14 \times 4-8 \mu$.

159.—*Psalliota bolorhiza* B. & Br.

Pileus 4 cm. diameter, almost plane, very slightly unbonate, margin repand when old; centre yellow-brown, tomentose, elsewhere sparsely covered with yellow-brown, fibrillose scales on a white ground, which assumes a purple tint when old. Flesh thin, white, darkening when cut. Stalk 5 cm. high, 4 mm. diameter, almost equal or slightly attenuated upwards, bulbous at the base (1 cm. diameter), white, shining, minutely silky, stuffed, then hollow. Ring evanescent. Gills narrow, attenuated at each end, crowded, free. Spores dark purple-brown in mass, pip-shaped, $4-5 \times 3 \mu$.

Among grass, solitary, Peradeniya.

160.—*Psalliota hemilasia* B. & Br.

Pileus up to 14 cm. diameter, plane, sometimes obtusely umbonate, often undulating, red-brown or purplish-red in the centre, elsewhere covered with minute innate fibrillose scales of the same colour on a white ground. Flesh white, up to 1.5 cm. thick in the centre, thinning out to the margin, turning yellowish just below the cuticle when cut. Stalk up to 12 cm. high, 1.5 cm. thick in the middle, base bulbous, or expanded and truncate, attenuated upwards, striate and shining above the ring, slightly fibrillose or squamulose below, white, hollow. Ring descending, ample, fragile, sometimes covered with red-brown warts on the lower surface. Gills widely free, somewhat crowded, comparatively narrow, white, then pink, finally purple-brown. Spores oval to subglobose, $4-7 \times 3-4 \mu$.

Usually among dead leaves, &c.; fairly frequent at Peradeniya, but not in large numbers.

161.—*Psalliota liturata* B. & Br.

Pileus almost plane, or slightly obtusely umbonate, up to 4 cm. diameter, at first purple-red in the centre, elsewhere white, with radiating purple-red streaks and spots, finally becoming purple-gray between the streaks. Flesh thin. Stalk up to 7 cm. long, 3-4 mm. diameter, inflated at the base, usually attenuated upwards, white, minutely scaly below the ring, shining and striate above, hollow, lined with shining white

fibrils, usually curved at the base ; ring weak, usually pendent, white. Gills at first white, then pale pink, finally purple-brown, rather narrow, attenuated behind, widely free, sometimes slightly ventricose. Spores purple-brown, oval, $5 \times 3 \mu$.

Berkeley and Broome's description was drawn up from Thwaites's figure 717*, which represents the fully developed purple-gray form. It is marked by Thwaites, "certainly identical with 714." There are two figures of 714 ; one of these was not named by Berkeley and Broome, but is without doubt *Psalliota liturata* ; the other is a half-expanded specimen, and from this Berkeley and Broome drew up their description of *Lepiota muticolor*. From recent collections it would appear that Thwaites's statement was correct, and that *Lepiota muticolor* is merely young *Psalliota liturata*.

Psalliota celidota is most probably an old specimen of *Psalliota liturata*. Berkeley and Broome, in describing the figure, stated that the flesh of the pileus was white, except at the head of the stalk, where it was dark umber. This is a common feature in old specimens of Ceylon *Psalliotas*. The inner layers of the stalk turn brown first, the extreme outer layer remaining white.

162.—*Psalliota zeylanica* n. sp.

Of the paintings of agarics, sent by Thwaites to Berkeley and Broome, two, one marked 753 and 763, and the other marked 1155, were referred by them to *Agaricus campestris* var. It is doubtful whether the two paintings represent the same species, but the second of them has been identified with fresh specimens, and proves to be distinct from *Psalliota campestris*. It may be known as *Psalliota zeylanica*.

Pileus at first conico-cylindric, densely clothed with dark rufous-brown or blackish-brown, adpressed, fibrillose scales ; then broadly convex, or almost plane, the larger specimens obtusely umbonate, up to 12 cm. diameter, clothed with rufous-brown, adpressed, fibrillose scales and radial fascicles of fibres. Flesh thin, white. Stalk 4.5–5.5 cm. high, 6–12 mm. diameter, equal or slightly attenuated upwards, base bulbous, often with cord-like mycelium attached, silky striate and shining above the ring, fibrillose, white becoming brown,

below; internally white, hollow. Ring descending, weak, edge sometimes brown. Gills at first dingy cream-coloured, becoming yellow when cut, then pallid brown, finally purple-brown, widely free, rounded behind, attenuated outwards, slightly ventricose in large specimens, crowded. Spores pale purple-brown, $4.5 \times 3 \mu$.

On the ground among grass, in troops, Peradeniya.

Psalliota zeylanica.—Pileo primo conico-cylindrico, fusco-rufis squamulis dense vestito; deinde late convexo vel plano, ad 12 cm. diam., rufo-brunneis adpressis fibrillosis squamulis vestito; carne tenui, albo. Stipite 4.5–5.5 cm. long., 6–12 mm. diam., æquale vel leniter sursum attenuato, cavo, basi bulboso, supra sericeo-striato, nitente, deorsum fibrilloso, albo, brunnescente; annulo descendente, fragili, margine brunneo. Lamellis primo sordide cremicoloribus, secto flavescentibus, deinde purpureo-brunneis, late liberis, post rotundatis, exteriore attenuatis, confertis. Sporibus pallide purpureo-brunneis, $4.5 \times 3 \mu$.

163.—*Psalliota endoxantha* B. & Br.

Pileus campanulate or convex, then almost plane, often obtusely umbonate, up to 10 cm. diameter, blackish-brown in the centre, elsewhere covered with black, black-brown, or gray, minute, adpressed scales or points. Flesh white, moderately thick. Stalk up to 20 cm. long, 1 cm. diameter, white, attenuated upwards or equal, sometimes bulbous at the base, smooth or floccose below the ring, hollow, turning yellow at the base when cut; ring variable, ample, thick, floccose or firm. Gills pink, then purple-brown, free, rounded behind, rather crowded. Spores purple-brown, oval, $4.7 \times 3.4 \mu$.

On the ground among grass, usually under trees and in large troops, up to 250, Peradeniya.

Psalliota actinorachis B. & Br. is this species, with the outer layers of the pileus cracked radially and transversely. *Psalliota lepiotoides* B. & Br. is a dwarf, partly expanded specimen. The yellow discolouration at the base of the stem is very fugitive, and it is difficult to obtain specimens which show it as the base of the stem is usually attacked by insects as soon as the pileus is expanded.

164.—*Psalliota erythrospila* B. & Br.

Pileus up to 1.5 cm. diameter. hemispherical, convex or conico-convex, or almost plane, purple-red, the cuticle broken into minute scales; margin at first appendiculate. Stalk up to 3 cm. high, 1.5 mm. diameter, white, equal, minutely tomentose; ring ascending, white, upper edge purple-red. Gills ventricose, rather crowded, free, but close to the stem, white, then purple-brown. Spores purple-brown in mass, almost hyaline by transmitted light, oval, $6 \times 4 \mu$.

In Ann. Perad., IV., p. 55, this species was referred to *Lepiota earochroa* B. & Br. That has proved to be incorrect.

165.—*Psalliota arginea* B. & Br.

Pileus broadly conico-campanulate, obtusely umbonate, up to 1 cm. diameter, white or grayish-white, the umbo becoming pinkish-red, membranous, radially silky striate. Stalk up to 2 cm. long, 1 mm. diameter, often flexuose, white, shining, powdered, stuffed; ring small, spreading, persistent. Gills pinkish, then pale brown, ventricose, free. Spores pale purple-brown in mass, oval, slightly inequilateral, $4 \times 2.5 \mu$.

On bare ground, Peradeniya.

166.—*Psalliota microcosmus* B. & Br.

Gregarious; pileus conical, then conico-campanulate, obtusely umbonate, up to 4 mm. diameter, white, silky with short adpressed fibrils; flesh white, comparatively thick over the stalk. Stalk up to 1.3 cm. high, 1 mm. diameter, white, minutely fibrillose; ring near the apex, spreading horizontally, rigid; apex of stem silky striate. Gills pallid, then pale purple-brown, crowded, free, but close to the stem, ventricose. Spores pale purple-brown, oval, $5 \times 2.5 \mu$.

On bare ground, Peradeniya, with *Ps. arginea*; a stouter species than the latter, not striate, but perhaps only a smaller, more compact form of it. Stains the paper purple when pressed.

167.—*Psathyra obtusata* Fr.

Berkeley and Broome recorded, as *Psathyra obtusata* Fr., Thwaites's 711*, 712, 829, cum iconibus, and as *Psathyra spadiceo-grisea* Schæff., Thwaites's 712***, 754, cum iconibus.

It is evident from the available specimens and figures that these were mixtures, though it has not been possible to match them all with fresh specimens. Thwaites's 712, however, is a very common species, which grows in troops round decaying stumps, following the lines of the lateral roots. It sometimes occurs in company with *Psathyra trechispora* Petch, which has the same habit; but I have not been able to ascertain that the names quoted cover the latter species. It is not *Psathyra obtusata*. Thwaites's figure, 712, represents poor, unexpanded specimens.

The pileus is at first conical, then broadly conico-convex or almost plane, up to 6 cm. diameter, sometimes with a conical umbo, bay-brown to ashy, darker in the centre, and when ashy, frequently with a purple tinge towards the margin, radially ridged with slightly elevated anastomosing ridges, sometimes atomate, sometimes with scattered, floccose remains of a veil. The flesh is thin and the pileus fragile. The stalk is up to 8 cm. long, and 8 mm. diameter, white, shining, brittle, sparingly floccose, longitudinally striate, attenuated upwards, hollow. The gills are pallid, then purple-brown with a white edge, crowded, adnate, subventricose, up to 7 mm. broad. They bear fusiform or flask-shaped cystidia, 40–50 μ high, 16–20 μ at the widest, with the wall strongly thickened at the apex (up to 8 μ thick) and thinning off along the sides just below. The spores are purple-brown, narrow-oval or oblong-oval, inequilateral, 6–7 $\times$ 4 μ . It may be known as *Psathyra reticulata*.

***Psathyra reticulata*.**—Pileo primo conico, deinde late conico-convexo vel plano, ad 6 cm. diam., interdum acute umbonato, badio vel cinereo, centro saturatiore, lirellis parum elevatis anastomosantibus reticulato, modo atomato, modo floccoso; carne tenui, fragili. Stipite ad 8 cm. long., 8 mm. diam., albo, nitente, fragili, sparse floccoso, longitudinaliter striato, cavo, sursum attenuato. Lamellis pallidis, deinde purpureo-brunneis, margine albo, confertis, adnatis, subventricosis, ad 7 mm. latis. Sporibus purpureo-brunneis, anguste ovalibus vel oblongo-ovalibus, inæquilateralibus, 6–7 $\times$ 4 μ . Cystidiis fusiformibus, 40–50 μ long., 16–20 μ diam., apice in-crassato.

168.—*Hygrophorus firmus* B. & Br.

Fasciculate. Pileus 2–3·5 cm. diameter, deeply umbilicate, margin decurved, finally infundibuliform, orange-red to orange-yellow, becoming pale yellow when old, glabrous. Total height up to 6·5 cm. Flesh yellow. Stalk yellowish-red or reddish-orange, yellow at the base, expanding upwards, 3–5 mm. diameter in the middle, glabrous, stuffed, then hollow. Gills pale yellow, distant, broad (up to 4 mm.), decurrent. In all the spore prints of this species, two sizes of spores occur, one $13\text{--}16 \times 9\text{--}12 \mu$, oval, closely and minutely warted; the other $6\text{--}7 \times 5\text{--}6 \mu$, smooth, subglobose.

On the ground, among grass, in clusters of twenty or more, the clusters often arranged in rings.

The specimens attributed to *Hygrophorus lætus* Fr., Fungi of Ceylon, 318, appear to be this species; and, from the figure, *Clitocybe anisa* B. & Br., Fungi of Ceylon, 85, is the same.

169.—*Hygrophorus cæsius* B. & Br.

Pileus broadly convex, then expanded, margin repand and split, up to 4·5 cm. diameter, dark green, with densely clustered, dark olive, wart-like scales in the centre, and scattered, dark olive points and striæ elsewhere; showing blue where the cuticle is split. Flesh thin, green when cut. Stalk up to 5 cm. high, 3–7 mm. diameter, equal or fistulose, stuffed, then hollow, deep indigo-blue, becoming pale blue, smooth, shining, pale blue internally. Gills at first deep Prussian blue, gradually becoming dull green, broad (up to 9 mm.), distant, thick, ventricose, slightly sinuate behind, broadly adnate, strongly veined above, interstices veined. Spores white, oval, $7\text{--}9 \times 4\text{--}5 \mu$.

On the ground, among grass, Peradeniya.

Hygrophorus multicolor B. & Br., Fungi of Ceylon, 317, would appear to be very close to this species. It has a longer stalk, white at the base. But the specimen bears a note by Thwaites, "Blue, shaded with green, yellow, and orange." The figure, however, does not show any yellow or orange.

170.—*Hygrophorus roseostriatus* B. & Br.

This species is common at Peradeniya, growing among grass in large rings. The pileus is conico-campanulate, then almost plane, obtusely umbonate, crimson, or crimson with yellow streaks, or entirely yellow or orange-yellow, up to 5 cm. diameter, with adpressed fibrils, which become ashy in drying. Flesh thin, yellow, white in the centre. Stalk up to 7 cm. long, 1 cm. diameter, pale yellow to orange, white at the base, stuffed, then hollow, white or yellow internally. Gills often irregular, thick, distant, ventricose, up to 1 cm. broad, free or sinuato-adsinate, pale yellow or orange-yellow. Spores white, $8-10 \times 4-5 \mu$.

This species has several other names in the Fungi of Ceylon. It is "324, *Hygrophorus ceraceus* Fr. var. *moschatus* B. & Br.," and "337, *Hygrophorus chlorophanus* Fr." *Hygrophorus bicolor* B. & Br. is a specimen which has been caught by dry weather, and *Hygrophorus glanduliformis* B. & Br. is a distorted specimen.

171.—*Hygrophorus elegantissimus* B. & Br.

Pileus conico-campanulate, then broadly convex, umbonate, up to 4 cm. diameter, at first brown with a pinkish tinge, then pale pink, sometimes retaining the brown colour at the margin, innately silky striate when dry; margin irregular. Flesh pink. Stalk pink, up to 4.5 cm. high, 5 mm. diameter, equal, or inflated below, smooth, glabrous, stuffed. Gills pale pink, whitish at the edge, distant, broad, ventricose, veined, edge irregular, decurrent with a broad sinus. Spores, white, broadly oval, $6-9 \times 4-6 \mu$. The whole fungus becomes reddish-orange when decaying.

On the ground, among grass, Peradeniya, July, 1908; July, 1913.

172.—*Hygrophorus cinerascens* B. & Br.

Pileus at first broadly convex, centre depressed, sometimes becoming almost plane, with a repand and undulating margin, 5 cm. diameter; or conico-campanulate, up to 5 cm. diameter and 3 cm. high; livid brown when moist, becoming gray-brown, streaked with ashy innate fibrils, margin usually pale;

cuticle splitting when old into radial fascicles and scales of adpressed fibrils; turning black when drying. Often fissured in the centre and exposing the hollow stalk; flesh livid-brown over the gills. Stalk up to 7 cm. high, 3-8 mm. diameter, equal, often compressed and irregularly sulcate, pallid, then pale livid brown, glabrous, stuffed, soon hollow, turning pink internally when cut; base fibrillose or tomentose. Gills pallid, then cinereous or lead-coloured, broad (up to 1 cm.), ventricose in large specimens, regularly attenuated outwards in small plane specimens, broadly adnate with a decurrent tooth, sometimes sinuate behind, margin irregular. Spores white, oblong oval, $6-9 \times 4-6 \mu$. Has a strong nitrous smell.

Among grass, in rings, Peradeniya.

Hygrophorus cinereus B. & Br. (Thwaites's figure 1195) appears to be merely a young *Hyg. cinerascens*.

173.—*Hygrophorus erinaceus* Pat.

The specimens attributed by Berkeley and Broome to *Hygrophorus conicus* var., Fungi of Ceylon, 329, agree with the description of *Hygrophorus erinaceus* Pat.

Pileus up to 3.5 cm. diameter, broadly convex, or almost plane and undulating, greenish-yellow, densely covered with black-brown, or olive-brown, minute scales and streaks. Flesh greenish-yellow. Stalk up to 4.5 cm. long, 3-7 mm. diameter, greenish-yellow, glabrous, stuffed. Gills greenish-yellow, distant, ventricose, sinuate behind, decurrent. Spores white, broadly oval, or somewhat pyriform, $6-10 \times 5-8 \mu$.

Among grass, under trees, Peradeniya.

174.—*Hygrophorus dimorphus* (B. & Br.).

This species was described by Berkeley and Broome as *Agaricus (Clitocybe) dimorphus* in Fungi of Ceylon, 86.

Pileus broadly campanulate or almost plane, depressed or rather acutely umbonate, 2-2.5 cm. diameter, orange in the centre, pale yellow outwards, margin sometimes whitish, smooth, subdiaphanous, radially striate. Flesh yellowish. Stalk up to 3 cm. long, 3-4 mm. diameter, fistulose, equal, or attenuated at the base, white or faintly yellow, feebly

longitudinally silky, stuffed, then hollow. Gills cream-coloured, yellow when old, distant, rather narrow, decurrent, connected by strong veins. Spores white, oval, $7-8 \times 4 \mu$.

On the ground, in flower beds, Peradeniya.

175.—*Cantharellus humilis* B. & Br.

Whole plant 3–5 cm. high. Pileus 3–6 cm. diameter, deeply infundibuliform, the hollow extending to the base of the stalk, white or pallid, glabrous, margin undulating, sometimes lobed; flesh thin. Stalk 1–1.5 cm. high, 3–4 mm. diameter, hollow, expanding upwards, white, becoming ochraceous when dry, slightly tomentose above, strongly tomentose below. Lower surface of the pileus white; gills narrow, repeatedly forked, united by numerous veins. Spores white, oval, $4 \times 3 \mu$.

On the ground among dead leaves and twigs, which are bound together by the mycelium, often caespitose, Peradeniya.

176.—*Lentinus apalus* B. & Br.

Thwaites's 725 was divided by Berkeley and Broome into two species, *Clitocybe candicans* Pers. and *Lentinus apalus* B. & Br. The figure was named *Clitocybe candicans*. The type specimens of *Lentinus apalus* include a group of *Lentini*, but these are correctly marked off by Berkeley as *Lentinus manipularis* B. & Br. The remainder of the specimens grew on the ground, and they are identical with the Ceylon specimens of *Clitocybe candicans*.

This species proves to be a *Clitopilus*, and will stand as *Clitopilus apalus*. It is gregarious, often connate at the base, 2–3.5 cm. high, with a pileus, 2–3 cm. in diameter, at first umbilicate with the outer half plane, then infundibuliform, margin incurved, white, smooth, shining, generally circular in outline, but sometimes elliptical and undulating at the margin. The gills are at first white, then faintly pink, decurrent, moderately crowded, narrow. The stalk is about 1.5 cm. high, 3 mm. diameter, expanding upwards, at first white, slightly tomentose, then pinkish, strongly tomentose at the base, solid. The spores are dull pink, broadly oval, $5-6 \times 4 \mu$. It has a strong smell of meal.

177.—*Coniophora Broomeiana* Mass.

The type in Herb. Kew is Thwaites's 256. It is an immature Hypoxylon, of the same type as *Sphæria albofulla* B. & Br.

178.—*Sphærella Chionanthi* (B. & Br.) Cooke.

Sphæria (*Obturatoræ*) *Chionanthi* was described by Berkeley and Broome in Fungi of Ceylon, 1114, as "Peritheciis minutis epidermide hyalina tectis; sporidiis uniseptatis; spermatiiis aculearibus (518). On *Chionanthus zeylanica*, Dambool, March, 1868. Forming little yellow patches consisting partly of the minute perithecia, partly of the larger bodies containing the spermatia; sporidia $20 \times 7.5 \mu$; spermatia $12.5-20 \mu$ long." In Saccardo, I., p. 549, it was listed as *Didymella Chionanthi* (B. & Br.) Sacc.; while Cooke, in Jour. Bot., 1883, p. 107, transferred it to *Sphærella*, stating that the asci were cylindrico-clavate and the spores fusiform, one-septate, $18 \times 5 \mu$.

The type in Herb. Kew is labelled "on *Chionanthus zeylanica*," a plant now known as *Linociera purpurea* Vahl. But the co-type in Herb. Peradeniya is labelled "Thw. 518. Dambool. *Memecylon umbellatum*." The two specimens are identical, both as regards host plant and fungus, and from specimens recently collected there is no doubt that the plant is *Memecylon umbellatum*.

On the upper surface of infected leaves the fungus causes pale yellow, somewhat diffuse spots, with a broad yellow-green margin. On the lower surface the spots are bright orange-yellow and circular, and bear orange-red, pulvinate, sub-translucent swellings, the pycnidia, or minute, dark red, circular points, the ostiola of the perithecia, either separately or intermixed.

The pycnidia are lenticular, subepidermal, raising the epidermis in minute blisters, either oval or circular, up to 0.6 mm. broad and 1.2 mm. long. The overlying epidermis is orange-red, not hyaline. The pycnidium is about 0.5–1 mm. thick, with an orange-yellow basal layer. The pycnospores are linear, straight or curved, $11-18 \times 1-2 \mu$.

The perithecia are totally immersed, pyriform, 0.25 mm. diameter, and 0.3 mm. deep. The perithecial wall is stout, and orange-yellow. The asci are cylindrico-clavate, $140-180 \times 11-12 \mu$, with a very stout pedicel and a well-developed foot. Numerous paraphyses are present, and spermatia identical with the pycnospores. The ascospores are fusoid, or narrow-oval attenuated towards one end, thick-walled, wall rough, greenish-hyaline, $16-22 \times 6-7 \mu$. They are not septate, as far as I can discover from the co-type and from fresh specimens; some spores show a pale transverse line near the centre, but, on staining with cotton blue, a broad blue band appears across the spore, showing a concentration of the cell contents there.

It is evident that the fungus is a *Hyponectria*, and it may stand as *Hyponectria Memecyli*. Should the spores prove to be uniseptate ultimately, it would be *Charonectria*.

179.—*Diatrype irpex* B. & Br.

This was described by Berkeley and Broome in *Fungi of Ceylon*, 1083. They stated that it was "late effusa," and in Saccardo, II., p. 145, it is listed as *Melogramma*. Berlese, *Icones Fungorum*, Tab. XXVII., fig. 3, figures it under the name *Rhyncosphæria irpex* (B. & Br.) Berl.

The perithecia are up to 0.75 mm. diameter, superficial, densely crowded, but not confluent, in large patches; globose below, passing rather gradually into a long cylindrical ostium up to 5 mm. long, and 0.2 mm. diameter, black or black-brown, strigose, becoming glabrous. There is a thin purplish film of mycelium between the perithecia, which spreads beyond them over the substratum. I have not seen the conidia described by Berkeley and Broome. The asci are clavate, eight-spored, the sporiferous portion measuring $160-175 \times 16-20 \mu$; the spores are biseriolate, or uniseriolate below and in an irregular bundle above. The spores are fusoid in one aspect, elongated cymbiform in another, straight or slightly curved, 7-8 septate, not constricted at the septa, thin-walled, ends obtuse, black-brown, with the terminal loculi paler, $52-70 \times 8-10 \mu$. Berlese's classification appears to be correct.

180.—*Diatrype theloides* B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, 1082, from Thwaites's 543, as "Pustulata, ostiolis lævibus in disco parvo crumpente collectis; sporidiis allantoideis. Pustules closely adnate with the cuticle, which is blackened, sometimes merely lifting it up; sporidia, .0003 (inches) long."

The type specimen in Herb. Kew shows blackened oval areas, about 2 mm. diameter, slightly elevated, covered, except at the apex, by the radially ruptured epidermis; other areas, not so definitely blackened and more widely split, show groups of projecting ostiola. The stroma is immersed in the bark, and is about 1.5 mm. diameter; it consists of a group of oval, or globose, perithecia or pycnidia, 0.3–0.4 mm. diameter. The pycnidia have stout, barely projecting ostiola; the ostiola of the perithecia are produced into cylindrical or clavate necks, up to 0.5 mm. high and 120 μ diameter, which converge to a common centre. Within the cortex above and below the fructification, and at a little distance from it, is a thin black layer, which encloses the perithecia or pycnidia and the cortical tissues in a Valsa-like lenticular stroma. This is more evident in the pycnidial stromata, over which it forms the blackened areas noted above.

The wall of the perithecium is cellular and not carbonaceous. The pycnosporos are linear, straight or curved, $4-6 \times 0.75 \mu$, hyaline. The asci are clavate, not long pedicelled, small, about $24 \times 5 \mu$, eight-spored. The spores are hyaline, cylindric, curved, $6-8 \times 2 \mu$. The fungus is apparently Valsa, and will stand as *Valsa theloides* (B. & Br.).

181.—*Diatrype chlorosarca* B. & Br.

Stromata erumpent, up to 2 mm. diameter, flattened pulvinate, almost plane, up to 0.8 mm. thick, minutely furfuraceous becoming glabrous, rarely showing projecting perithecial elevations; ostiola depressed, surrounded by a raised ring; internally greenish-yellow, perithecial walls black, brown when mounted. Perithecia globose, 0.4 mm. diameter, or flask-shaped, up to 0.7 mm. high, 0.4 mm. diameter,

usually in a single layer. Asci eight-spored. Spores cylindric, curved, greenish-hyaline or fuscous, $8-10 \times 2 \mu$.

Found recently on dead branches of *Hevea brasiliensis*. The figure in Berlese, Icones, III., plate CXV., is not typical. In general the stroma is flat, with a single layer of perithecia, and pulvinate stroma which show distinct perithecia are rare. The ostiola, too, do not project as shown in the figure; except with a high magnification they are not discernible.

182.—*Diatrype griseotecta* B. & Br.

Described by Berkeley and Broome as "Peritheciis globosis immersis nigris, ostiolo papillæformi, e bysso griseo emergentibus." They stated that the spores were 25μ long, scarcely mature. Cooke, in Grevillea, XIII., p. 58, stated that it was not a *Diatrype*, and that the spores were $40 \times 3 \mu$.

The co-type in Herb. Peradeniya has scattered, superficial perithecia, black, subglobose below, conical above, with a fluted ostiolum. The perithecial wall is not carbonaceous, and is areolated (by transmitted light). The substratum is covered by a thin layer of purple-brown hyphæ, which extends over the perithecia, leaving only the apices naked. The perithecia are "immersed" in this layer, not in the wood. The asci are cylindrico-clavate with a thickened apex, up to $200 \times 16 \mu$, eight-spored, and the spores are cylindric, with rounded ends, about $60 \times 4 \mu$. They are immature, but from the structure of the perithecium, and comparison with immature examples of *Bombardia Janus* (B. & Br.) Petch, this species is evidently an immature gathering of the latter.

183.—*Eriosphæria imitatrix* (B. & Br.) Sacc.

This species was described in Fungi of Ceylon, 1086, as "*Sphæria* (*Byssisedæ*) *imitatrix* B. & Br. Lata effusa, e strato nigro oriunda; peritheciis minutis collapsis asperulis; sporidiis uniseptatis." The spores were said to be oblong, subcymbiform, 15μ long.

In the co-type in Herb. Peradeniya the perithecia are crowded together, seated on, or partly immersed in, a thin layer of purple-brown hyphæ. They are about 0.3 mm.

diameter, collapsed, rugose, without a projecting ostium, bearing short, irregular, erect hyphæ or remnants of conidiphores. The wall is cellular, not carbonaceous. The asci are shortly pedicellate, $135-150 \times 10 \mu$, subcylindric, eight-spored. Linear paraphyses are present. The ascospores are greenish-hyaline or pale fuscous, oval, one-septate, constricted at the septum, ends rounded, $15-20 \times 7-9 \mu$. It appears to be correctly placed in *Eriosphæria*.

184.—*Eriosphæria nigrita* (B. & Br.) Sacc.

This was described by Berkeley and Broome in *Fungi of Ceylon*, 1091, as "*Sphæria* (*Byssisedæ*) *nigrita* B. & Br. Mycelio acanthimorpho; peritheciis minute hispidulis; ascis linearibus; sporidiis ellipticis submetulæformibus, uniseptatis utrinque hyalinis. The mycelium resembles that of *S. acanthostroma* Mont.; but the sporidia are much larger, besides having the tips hyaline; sporidia .0005 (inches) long."

The perithecia are embedded in a compact layer of mycelium which is composed of stout (7μ diameter) branched interwoven hyphæ. The hyphæ do not resemble those of *Sphæria acanthostroma*, but in the younger parts they terminate in long, acute, spine-like branchlets, often in groups of three. The perithecia are globose, about 0.3 mm. diameter, covered with spreading setæ, which are cylindric below, tapering and acute above, black, opaque, $50-100 \times 6 \mu$. The wall of the perithecium is cellular and rather thick. The ascospores are oval, with rounded ends, three-septate, slightly constricted at the septa, at first hyaline, the two middle cells becoming dark brown, the smaller terminal cells remaining hyaline and ultimately collapsing, so that the ends appear truncate. They measure $16-20 \times 7-8 \mu$. Berkeley and Broome's measurement probably refers to the collapsed barrel-shaped spore.

This is evidently *Chætosphæria*, and will stand as *Chætosphæria nigrita* (B. & Br.).

185.—*Chætosphæria bihyalina* (B. & Br.) Sacc.

The original description, in *Fungi of Ceylon*, 1087, is "Effusa, nigerrima; peritheciis globosis collapsis minutissime

granulosis e mycelio byssoideo oriundis; sporidiis cymbiformibus triseptatis utrinque hyalinis." The spores were said to be $30-62.5\ \mu$ long. The second of these figures is probably a misprint. The species was figured by Berlese, in *Icones Fungorum*, I., pl. XVII., fig. 6.

The perithecia are crowded or scattered, seated on, or embedded in, a purple-brown byssoid mycelium. They are about $0.3\ \text{mm.}$ diameter, minutely rugose, collapsed, and strongly resemble those of *Eriosphaeria imitatrix*, but they are not villous. The asci are clavate, shortly pedicelled, about $90 \times 16\ \mu$. The spores are subcymbiform, straight or curved, ends rounded, three-septate, constricted at the median septum, the two middle cells pale brown, and the terminal cells hyaline, with one of the middle cells frequently inflated, $28-32 \times 5-8\ \mu$.

Berlese's figure was taken from a specimen collected in Europe by Prof. Saccardo, which had been "minutiose" compared with the type. But he states that the spores are $18-22 \times 6-7\ \mu$, and show a villous perithecium. It is probable that the European species is not the same as that from Ceylon.

186.—*Schizostoma pachythele* (B. & Br.).

Perithecia scattered or gregarious, globose, about $0.8\ \text{mm.}$ diameter, rough, black, with a conical or orbicular crest (oval in cross section), up to $0.3\ \text{mm.}$ high, extending over about one-half the perithecium. Asci clavate, apex rounded, $100-112 \times 6-7\ \mu$; sporiferous part $52-62 \times 6-7\ \mu$, with a long, tapering, curved pedicel; spores biseriate. Paraphyses numerous, linear. Spores blackish-brown, fusiform, one-septate, appearing spuriously three-septate, deeply constricted at the septum and readily breaking into two, $17-20 \times 4\ \mu$.

This was described by Berkeley and Broome as *Sphaeria* (*Macrostomæ*) *pachythele*. Saccardo (*Michelia*, I., p. 336) included it in *Schizostoma*. Berlese, *Icones Fungorum*, Vol. I., p. 2, gives the spores $14-16 \times 3.5-4\ \mu$. The spores appear three-septate, owing to the contraction of the contents from the ends.

187.—*Fracchiæa Broomeiana* (Berk.).

Sphæria Broomeiana was described by Berkeley in Hooker's London Journal of Botany, VI. (1854), p. 231, from Ceylon specimens. In Saccardo, Sylloge, I., p. 106, it was listed as *Coronophora Broomeiana*. No spore measurements were given. In Notices of North American Fungi, Grevillea, IV., p. 47, Berkeley subsequently described *Cucurbitaria brevibarbata* B. & C., which was included in Saccardo, Sylloge, I., p. 94, with a query, as *Fracchiæa brevibarbata*. In Grevillea, XX., p. 113, Cooke stated that *Fracchiæa brevibarbata* "was found on *Acer rubrum* in South Carolina, on bark in Ceylon, and on *Rhus copallina*, Santee Canal, S. Carolina." In the cover of *Fracchiæa brevibarbata* at Kew is a specimen from Ceylon, labelled "*Sphæria Broomeiana* Berk. Ceylon G. H. K. T., Sept. 10, 1850." This is the type of *Coronophora Broomeiana*. Evidently Cooke considered *Coronophora Broomeiana* to be identical with *Fracchiæa brevibarbata*.

Fracchiæa brevibarbata was figured and re-described by Berlese (Icones Fungorum, III., p. 27, pl. XXXV., fig. 2) as "Perithecia in greges parvos cæspitose collecta, globoso depressa, sed sæpius mutua pressione difformia, stromate crustaceo, effuso vel vix pulvinato insidentia, subinde etiam breviter stipitata, rugoso-aculeata, aspera, nigra, superficialia, $\frac{1}{3}$ – $\frac{1}{2}$ mm. diam.; asci late clavati, longe et abrupte stipitati, 110–120 $\times$ 14–18, parte sporifera 55–65 et stipite 45–65 μ long., polyspori; sporidia allantoidica, 6–7 $\times$ 1.5–2, hyalina." He stated that he had examined specimens from the original collection sent to him by Cooke.

Sphæria Broomeiana, according to the type specimen, has globose perithecia, about 0.5 mm. diameter, clustered in groups of about a dozen, forming small pulvinate heaps. They are in some cases flattened above, with a minute conical ostiolum. The surface is echinulate, with short conical spines up to 32 μ high, 10 μ diameter at the base, which bear minute projections along their sides. The asci are clavate, polysporous, the sporiferous part measuring 75–100 $\times$ 15–20 μ , with a tapering pedicel 36–50 μ long. The spores are cylindric, curved, greenish-hyaline, 5–7 $\times$ 2 μ . The species is evidently *Fracchiæa*, and will stand as *Fr. Broomeiana*.

The American species, specimen on *Rhus* examined, is practically identical. Its perithecia are clustered, about 0.5 mm. diameter, with a minute conical ostiolum; the apex is not flattened. The surface is echinulate, with conical spines, up to 30 μ high, which are not so markedly thorny along their sides as in the Ceylon specimens. The asci are smaller than in the Ceylon species, the sporiferous part measuring 55–65 $\times$ 16–18 μ , and the pedicel about 30 μ ; but the spores are larger, 8–10 $\times$ 1.5 μ , hyaline. The spores do not appear to be quite mature, but even so they are longer than in *Fr. Broomeiana*.

It will be noted that Berlese's measurement of the spore agrees with that of *Fr. Broomeiana*, and his measurement of the ascus with *Fr. brevibarbata*. If both his measurements are from the same American specimen, it must be assumed that the spores may vary 5–10 $\times$ 1.5–2 μ . The earliest name is *Sphæria Broomeiana*.

188.—*Trichosphæria acanthostroma* (Mont.) Sacc.

Thwaites's 1029 was referred to this species by Berkeley and Broome. It consists of a thin, purple-brown, somewhat velvety stratum of mycelium, extending for several centimetres, and composed of suberect, rigid, flexuose hyphæ, with simple or forked, acute, lateral branches. The perithecia are scattered, 0.2 mm. diameter, globose, without an evident ostiolum, collapsing into a cup when dry. The perithecial wall is brown by transmitted light, cellular, almost membranous, and smooth. The asci are eight-spored, with narrow-oval, hyaline, continuous spores, 5–7 $\times$ 2 μ , but they do not appear to be quite mature.

189.—*Trichosphæria regulina* (B. & Br.) Sacc.

Thwaites's 1075 was described by Berkeley and Broome as "*Sphæria (Byssisedæ) regulina*. Peritheciis minutissimis ovatis obtusis e mycelio tenui oriundis; ascis clavatis; sporidiis biseriatis oblongis curvatis tenuibus. Perithecia invisible to the naked eye; asci .003 (inches) long; sporidia .0008 by .0002." In Saccardo, *Sylloge*, I., 454, it is listed under *Trichosphæria*.

The perithecia are black, globose, 0·15–0·2 mm. diameter, minutely rugose, shining, with a minute conical ostiolum, at first covered with fragments of mycelium, becoming naked; they are crowded, seated on, or partly embedded in, a thin purple-brown layer of mycelium. The asci are eight-spored, clavate, $90\text{--}100 \times 10 \mu$. The spores are cylindric with rounded ends, straight or variously curved, three-septate, very slightly constricted at the septa, $16\text{--}24 \times 5 \mu$. The septa are scarcely visible, except under a high magnification.

This is a *Lasiosphæria*, and will stand as *Lasiosphæria regulina* (B. & Br.).

190.—*Lasiosphæria acanthigera* (B. & Br.).

Sphæria (*Villosæ*) *acanthigera* B. & Br. was described as "Peritheciis ovatis, sub lente pallide fuscis spinis brevibus latis concoloribus vestitis; sporidiis linearibus curvis. On dung. The spines of this species are extremely curious, broad at the base, resembling in miniature those of a rose. The sporidia, when mature, are probably like those of *S. hirsuta*; but in the specimens before us they are clearly young." It was included in Saccardo, Sylloge, II., 198, under *Lasiosphæria*.

The only specimen in Herb. Kew is part of the type, ex Herb. Cooke. In Herb. Peradeniya this species is included with *Sphæria nigrita*, Thwaites 596. The specimens sub *Lasiosphæria acanthigera* in Herb. British Museum, ex Herb. Broome, are the conidial fungus, "Thwaites 576, Dolosbagey," attributed by Berkeley and Broome to *Xylaria tentaculata*.

The specimens in Herb. Peradeniya are more mature than those in Herb. Kew. The perithecia are ovate, or conical above, 0·4 mm. diameter, now black, minutely aculeate. The perithecial wall is cellular, and the outer cells are produced into short spines, which, as stated by Berkeley and Broome, resemble the prickles of a rose. These spines are broadly conical below, with a narrow, conical, acute tip, which is curved or falcate; they are $24\text{--}34 \mu$ broad at the base and $28\text{--}34 \mu$ high. The asci are eight-spored. The spores are at

first hyaline and cylindric, about $66 \times 5 \mu$; they become oval, black-brown, opaque, $18-24 \times 9-11 \mu$, with a hyaline appendage, 5μ diameter, which ultimately disappears.

The mature spores show that this species is a *Sordaria*, and it will stand as *Sordaria acanthigera* (B. & Br.).

191.—*Lasiosphæria hemipsila* (B. & Br.) Sacc.

Thwaites's 1078 was described by Berkeley and Broome as *Sphæria* (*Villosæ*) *hemipsila*, "Sparsa; peritheciis minutis subglobosis dealbatis sursum nudis, basi filis rigidis munitis; sporidiis curvis flexuosis triseptatis. Sporidia biseriate, .002 (inches) long, triseptate." It was included under *Lasiosphæria* in Saccardo, *Sylloge Fungorum*, II., 198.

The specimen in Herb. Peradeniya is on a decaying palm frond, which bears here and there a thin film of mycelium and the scattered remains of conidiophores. The perithecia are scattered, superficial, ovoid, 0.25 mm. diameter, black, sparsely clothed up to the apex with rigid, spreading, shining hairs (stalks of conidiophores) up to 0.25 mm. long and 6 μ diameter. Paraphyses are present. The ascospores are cylindric or fusoid, straight or curved, three- to five-septate, scarcely constricted at the septa, pale brown, except the small terminal cells, which are hyaline, $36-48 \times 8 \mu$.

This species is figured by Berlese in *Icones Fungorum*, I., pl. 117, fig. 2, from part of the type communicated by Cooke. Berlese gave the ascus $150-160 \times 16-20 \mu$, and the spores $48-52 \times 6-8 \mu$. But he did not find the smaller, three-septate spore. His figure shows one seven-septate spore and others five-septate. The figure of the perithecium shows flexuose hairs, and in that respect is incorrect. Berlese retains it in *Lasiosphæria*, but it is evidently *Chætosphæria*, and will stand as *Chætosphæria hemipsila* (B. & Br.).

192.—*Lasiosphæria tephrocoma* (B. & Br.) Sacc.

This species was said to grow on palm leaves, but the type in Herb. Kew is on bamboo. The description is "*Sphæria* (*Villosæ*) *tephrocoma*. Peritheciis setis sparsis rigidis vestitis; ascis clavatis; sporidiis fusiformibus triseptatis; conidiis conformibus uniseptatis. Sporidia .0011 long; spores from

pyrenidia, .0004; helminthosporoid conidia .003 (inches).'' In Saccardo, *Sylloge Fungorum*. II., 198, it was placed in *Lasiosphæria*.

The substratum bears a thin purple-brown layer of mycelium, almost membranous, densely covered with the remains of erect, rigid conidiophores, up to 1 mm. high. These stalks are compound, about 30 μ diameter at the base, tapering to 16 μ above, and arise more or less in clusters. The perithecia are produced within the base of these clusters, and consequently bear the remains of the conidiophores, but these are readily detached; the perithecia are globose, black, about 0.3 mm. diameter. The asci are clavate, with a tapering pedicel, eight-spored, spores biserial, 40-50 $\times$ 6 μ . The spores in the perithecia examined by me were narrow-oval or subcylindric, with rounded ends, greenish-hyaline, one-septate, 6-9 $\times$ 2-3 μ . They were obviously immature, and Berkeley and Broome's statement that they are ultimately three-septate may be correct, but their measurement, 27.5 μ , is an error. There may be a mixture of species in the type, but the perithecia and spores described above clearly belong to the conidiophores, which form the chief part of it.

193.—*Lasiosphæria chloronema* (B. & Br.) Sacc.

Thwaites's 1109, which was immature, was described by Berkeley and Broome as "*Sphæria (Villosæ) chloronema*. Peritheciis globosis breviter albo-tomentosis, ostiolo nigro, intus materie viride repletis." In Saccardo, *Sylloge Fungorum*, II., 214, it is placed in *Lasiosphæria*.

The perithecia are scattered, superficial, globose, clothed with yellow interwoven hyphæ, the ostiolum black and projecting. The perithecial wall appears black in section, but when mounted is found to be parenchymatous, with a brown outer layer, blackening at the apex, and a yellow inner layer. The mass of asci and linear, septate paraphyses is yellow. The spores in the co-type in Herb. Peradeniya are not fully mature; they are hyaline, cylindric, straight or curved, multiguttulate, 30-36 $\times$ 4 μ .

194.—*Chætosphæria xanthotricha* (B. & Br.) Sacc.

This was described by Berkeley and Broome as "*Sphæria* (*Villosæ*) *xanthotricha*. Peritheciis aggregatis flavo-lanatis; ostiolo punctiformi nigro; sporidiis subcymbiformibus 4-5-septatis. Sporidia .00065 (inches) long." It was included in Saccardo, *Sylloge Fungorum*, I., p. 95, as *Chætosphæria*.

The perithecia are about 0.4 mm. diameter, superficial, gregarious, globose, with a papillate ostiolum, black, clothed, except at the ostiolum, with yellow spreading hyphæ, which extend slightly over the substratum at the base. The perithecial wall is parenchymatous, not carbonaceous, dark brown when mounted. The external hyphæ are septate, 3-4 μ diameter, slightly inflated at the tip, and strongly encrusted; yellow, oval, continuous conidia, 5-7 $\times$ 3-4 μ , are present, apparently borne on the external hyphæ. The asci are eight-spored, about 60 $\times$ 8 μ . The spores are fusoid, three- to five-septate, slightly constricted at the septa, ends obtuse, pale fuscous, 16-20 $\times$ 5 μ . It would perhaps agree better with *Lasiosphæria* than with *Chætosphæria*.

195.—*Melanomma Vesuvius* (B. & Br.) Berl.

Berkeley and Broome described this species as "*Sphæria* (*Pertusæ*) *Vesuvius* B. & Br. Sparsa; peritheciis magnis, e basi truncata conicis, ostiolo acuto; sporidiis fusiformibus fuscis biconicis, medio contractis, utrinque uniseptatis. On decayed wood. Perithecia $\frac{3}{4}$ line across and as much high; sporidia .0018 by .0005 (inches)." It was included in Saccardo, II., 119, as *Trematosphæria*. Berlese, in *Icones Fungorum*, I., p. 36, tab. 24, fig. 2, referred it to *Melanomma*.

The perithecia occur on decaying palm fronds. They are scattered, almost superficial, with the base slightly immersed, black, smooth, carbonaceous, conoid, with a minute conical ostiolum, base flat, 0.75-1.5 mm. diameter, 0.5-1 mm. high. The spores are pale to dark brown, fusoid, three-septate, constricted at the median septum, straight or slightly curved, ends obtuse, 38-48 $\times$ 6-8 μ , with one of the middle cells often inflated to 10 μ wide.

196.—*Trematosphæria agnocystis* (B. & Br.) Cooke.

This was described by Berkeley and Broome as "*Sphæria* (*Pertusæ*) *agnocystis* B. & Br. Immata, conica, coffeicolor, lævissima; ostiolo papillæformi; sporidiis biconicis, utrinque hyalinis. On dead wood." In Saccardo, I., 722, it was listed as *Amphisphæria*. Cooke, in Grevillea, XVI., p. 92, referred it to *Trematosphæria*, and gave the spore as three-septate, $40 \times 8 \mu$.

The type specimens are on a decaying palm frond. The perithecia are scattered, conical, with a flat base, almost superficial, with the base slightly immersed, up to 1 mm. diameter and 0.5 mm. high, with a thin purple-brown pruinose outer layer. The wall is black, carbonaceous, about 0.1 mm. thick. In some cases it bears a few scattered globose wart-like bodies, which are the immature perithecia of a parasitic *Sphæria*. The spores are pale brown, fusoid, three-septate, constricted at the median septum, ends obtuse, $33-39 \times 5-6 \mu$.

This species is very near *Melanomma Vesuvius*, but differs in the shape of the perithecium and the smaller, non-inflated spores. It must stand as *Melanomma agnocystis* (B. & Br.).

197.—*Rosellinia plicatula* (B. & Br.) Sacc.

This species was described by Berkeley and Broome as "*Sphæria* (*Cæspitosæ*) *plicatula* B. & Br. Fasciculato-congesta; peritheciis atris collapsis minute granulatis plicato-rugosis; sporidiis doliiformibus utrinque leviter attenuatis, nucleo magno (Nos. 39, 1069). On bark. Asci clavate, sporidia biseriate, .0006–.0008 long by .0004–.0005 (inches). Very near *Sphæria Pezizula* B. & Rav., which has shorter hyaline sporidia." In Saccardo, I., 261, it was included in *Rosellinia*.

Thwaites's 1069 shows superficial, irregularly circular, pulvinate stromata, up to 2.5 mm. diameter and 1 mm. thick. They appear to bear circular, flattened, rugose, discoid perithecia up to 0.15 mm. diameter, but sections through the stroma disprove that interpretation. The substance of the stroma is pseudoparenchymatous, and the perithecia are totally immersed; they are narrow-oval, up to 200μ deep and 70μ diameter, with a thin hyaline wall. The superficial bodies are immature, but appear to be pyrenidia; they are oval

or turbinate, about 0.1 mm. high, with a thick pseudoparenchymatous wall. The turbinate, flat-topped shape appears to be normal, not a result of drying. The asci are clavate, thick-walled, about $125 \times 16 \mu$, eight-spored. The spores are oval, continuous, pale brown to blackish-brown, thin-walled, ends usually rounded, rarely attenuated, $14-22 \times 6-11 \mu$. The stroma has the structure of *Botryosphæria*, and the species will stand in *Phæobotryosphæria* as *Phæobotryosphæria plicatula* (B. & Br.).

I have not seen Thwaites's 39, but Thwaites's 30 in Herb. Peradeniya is the same species. This was included by Berkeley and Broome in Fungi of Ceylon, 789, as a form of *Sphæropsis undulata* B. & C. with spores 17.5μ long. The *Sphæropsis undulata* of the Fungi of Ceylon is *Haplosporella Cesatii* Sacc. *Sphæria plicatula* bears a superficial resemblance to the latter species, and when the asci have disappeared the two might possibly be confused, but *Haplosporella Cesatii* has thick-walled spores. Thwaites's 30, however, contains asci. The wall of *Haplosporella Cesatii* is pseudoparenchymatous, not carbonaceous, as stated in Ann. Perad., IV., p. 61.

198.—*Thyridaria crocosarca* (B. & Br.) Cooke.

This species was described by Berkeley and Broome in the Fungi of Ceylon as "*Trypethelium crocosarca*. Croceum pulvinatum, contextu concolori; peritheciis nigris, ostioliis immersis; sporidiis fusiformibus multiseptatis. On wood. Forming little pulvinate masses, $\frac{1}{2}-\frac{3}{4}$ line wide, saffron yellow, dotted where the ostiola open; substance of the same colour; sporidia .0015 long by .0005, with twelve or more septa; paraphyses linear." The type in Herb. Kew was marked *Melogramma crocosarca* by Berkeley. Cooke, on finding the specimen under this name in Herb. Kew, published another description under the name of *Thyridaria crocosarca* in Grevillea, XX., p. 83. His description is "Erumpent. Perithecia saffron colour, mealy, cæspitose, 2-6 together, often confluent, on a narrow stroma, pierced at the apex, forming clusters 2 mm. long. Asci clavate, octosporous. Sporidia fusiform, 7-11-septate, pale, not constricted, $40 \times 12 \mu$, with linear paraphyses."

The perithecia are not separate, as would be supposed from Cooke's description, but totally immersed in a stroma. The stromata are elevated, covered at first by a thin lichen stroma, flattened pulvinate, irregularly circular, up to 2 mm. diameter, brownish-yellow or orange-yellow; the surface is smooth, or broken and minutely granular, dotted with dark, scattered ostiola. The stromata are about 0.4 mm. thick, greenish-yellow internally when fresh, orange-yellow in dried specimens; the context is rather loose and granular. The perithecia are in a single layer, somewhat distant from one another, and occupying nearly the entire thickness of the stroma; they are black, oval, about 0.3 mm. high, 0.2 mm. diameter, with a conical ostiolum, which does not project. The asci are clavate, thick-walled towards the apex at first, $140-160 \times 12-14 \mu$. The abundant paraphyses are linear, branched above. The spores are fusoid, ends obtuse, greenish hyaline, thick-walled, 7-11-septate, $36-50 \times 8-9 \mu$.

Berkeley and Broome described this species in a footnote, a course which they also followed in the case of *Platygrapha*. It is evident that they considered these to be lichens, and, in fact, *Trypethelium crocosarca* B. & Br. is identical with part of the Ceylon specimen assigned by Leighton to *Trypethelium Sprengelii* Ach., 196 in Trans. Linn. Soc., XXVII., p. 185. It is *Trypethelium*, not *Thyridaria* nor *Melogramma*.

199.—*Piptostoma spilotum* B. & Br.

This species was described from Thwaites' 348 as "Minutum, planum, cito circumcissum; ascis lanceolatis; sporidiis oblongis curvulis. Sporidia .0025 (inches) long." Saccardo, Sylloge, II., p. 813, places *Piptostoma* among the "Genera dubia," but in Sylloge, IX., p. 1054, it is included in *Microthyriaceæ*.

There is apparently no specimen of *Piptostoma spilotum* at Kew, the British Museum, or Peradeniya.

200.—*Sordaria sarawacensis* Ces.

This species was collected by Beccari, and was recorded by Cesati as occurring in both Ceylon and Sarawak. His description is "Perithecia ex hyphasmate subiculum sat tenax

albescens constituyente emersa, minutissima, atra, ovalia, in ostiolum acutum carbonaceum excurrentia, cæterum substantia minute vesiculosa. Asci tetraspori, sporidiis ovalibus utrinque obtusis, polo inferiori crasse caudato, $18\ \mu$ longa (quorum $10\ \mu$ appendicem ipsam spectant), $8-10\ \mu$ lata."

In Herb. Kew is a specimen ex Herb. Cesati. The perithecia are black, globose, up to 0.3 mm. diameter, furnished with a cylindric, or slightly attenuated, ostiolum, up to 0.2 mm. high and 0.1 mm. diameter. A thin, white layer of mycelium overlies the perithecia, and through this the ostiola project. The perithecia are free below. The specimen examined was too ripe to show asci, and I am therefore unable to confirm Cesati's statement that they are four-spored. But the spores are black-brown, oval, apex somewhat papillate, base truncate, $20-28 \times 9-12\ \mu$; they possess at first a hyaline appendage, of which some remnant occasionally persists in the herbarium specimen.

The perithecia and the white mycelial layer agree with Cesati's description, but the spore measurement is so different that one might suppose that this was not the species examined by him. It may be suggested that the published measurement, $9/500\text{ mm.}$, should be $19/500\text{ mm.}$; allowing $10\ \mu$ for the appendage, this would give a length agreeing with the dimensions found. As it stands, the length of the spore is less than the breadth, if the length of the appendage be deducted. The appendage, however, is certainly more than $10\ \mu$ long.

Following *Sordaria sarawacensis*, Cesati described *Sordaria punctiformis*, found on dung on Pedrutalagala, Ceylon. It was "Perithecia minutissima in subiculo crustaceo albicante, ovata, glabra, ostiola vix conspicuo; contextu grosse vesiculoso. Sporidia late ellipsoidea, fusca, simplicia, gutta centrali, $16 \times 14\ \mu$, ecaudata (an primitus?)." Asci were not seen. In Saccardo, Sylloge, I., p. 247, this is listed as *Hypocopra punctiformis*. But in his remarks on this species, Cesati added: "Calvities peritheciorum in nostro fungillo ex senescenti ejus ætate peti posset"; this would appear to negative the supposition that the species is *Hypocopra*, though he compared it to *Hypocopra discospora* Fek.

201.—*Sphærella Rottleræ* (B. & Br.) Sacc.

Berkeley and Broome described this species as "*Sphæria* (*Depazea*) *Rottleræ* B. & Br. Epiphylla, e macula umbrina pallida oriunda, orbicularis, nivea, limitata; peritheciis atris." It was said to occur on leaves of *Rottlera quadricocca* Roxb., evidently an error for *Rottlera tetracocca* Roxb., a plant now known as *Mallotus albus* Muell.-Arg. It was included in Saccardo, Sylloge, I., p. 536, as *Sphærella Rottleræ*. Cooke did not refer to it in his "*Sphærella* and its allies" (Jour. Bot., 1883).

In the type specimen, Thwaites's 1228 in Herb. Kew, the leaves bear circular, white spots, about 2.5 mm. diameter, surrounded by a broad, diffuse, purplish zone. The pycnidia are clustered in the centre of the spot, and are epiphyllous, subepidermal, black, about 0.15 mm. diameter. They do not contain asci, but oval, or subglobose, hyaline, continuous, obtuse pycnosporos, $7-12 \times 7-8 \mu$.

As Berkeley and Broome did not record any measurement or description of the spores, it is uncertain whether the form described above is the species seen by them. It is quite possible that perithecia may occur on some of the spots. But as far as examination of the type shows, the fungus is a *Phyllosticta* and must be known as *Phyllosticta Rottleræ* (B. & Br.).

The type in Herb. Kew is Thwaites's 1228. Under 1142, *Asterina nubecula* B. & Br., in the Fungi of Ceylon, Berkeley and Broome noted: "There is also a species on *Rottlera tinctoria* with depressed perithecia situated on snow-white spots, but unfortunately without fruit." This description fits Thwaites's 1228. The leaf in Thw. 1228 is that of *Mallotus albus* (*Rottlera tetracocca*).

202.—*Sphæria* (*Depazea*) *Oxalidis* Kirsch.

Under this name Berkeley and Broome placed Thwaites's 486, in Fungi of Ceylon, 1122. It occurred on *Oxalis corniculata*. They stated that the asci were broader at the base, 37.5μ long, 10μ broad, and the spores $10-12.5 \mu$ long, with from one to three nuclei. In Saccardo, I., p. 429, the Ceylon record was included under *Læstadia Oxalidis* (Rabh.) Sacc.

Cooke (Journal of Botany, XXI., p. 109) listed "*Sphærella Oxalidis* Kirsch. in Lotos, 1856, 203; Berkeley and Br., Ceylon Fungi, 1122," and added: "This is referred to *Læstadia Oxalidis* (1635) by Saccardo; but it is quite a different species, as will be evident from a comparison of the diagnosis in Lotos, and the description 1635. It approaches more closely to *Sphærella depazeæformis*, 1984. Whether all these may be forms of one species may be matter of opinion."

The Ceylon fungus produces membranous, circular, brownish-white spots, up to 2 mm. diameter. The perithecia are clustered in the centre of the spot, amphigenous, usually hypophyllous, black, about 75 μ . diameter, sub-epidermal, prominent. The asci are oval, or oblong-oval, sometimes attenuated upwards, with a short pedicel, $30-36 \times 8 \mu$. The spores are biseriate, narrow-oval or subcymbiform, straight or sometimes curved, one-septate, not constricted, hyaline, $10-11 \times 2.5 \mu$. It is certainly a *Sphærella*.

Læstadia Oxalidis (Rabh.) Sacc. is said to have asci $32-36 \times 8 \mu$, sessile, lanceolate; spores fusiform, ventricose, $14 \times 4 \mu$. *Sphærella depazeæformis* (Auersw.) Ces. et de Not. has perithecia $40-46 \mu$ diameter; asci ovate, attenuated below, $34-36 \times 8 \mu$; and spores fusiform-oblong, straight, one-septate, $8-10 \times 2.3 \mu$.

From the dimensions of the spores it would appear that the Ceylon species is near *Sphærella depazeæformis*, though the shape of the spores appears to be different. The shape of the ascus agrees with that described for *Læstadia Oxalidis*. It would seem possible, however, that these two species are the same, as Cooke suggested. I have not been able to consult the original description of *Sphærella Oxalidis* Kirsch.

203.—*Hypoxylon umbrinellum* B. & Br.

This was described in Fungi of Ceylon, 1075, as "Late effusum; peritheciis minutis ovatis metulæformibusque umbri-nellis materie furfuracea vestitis; ascis linearibus; sporis subellipticis, uniseptatis, demum echinulatis (1111). On dead wood with Byssisedæ. Margin of the stroma often barren, as in *H. rubiginosum*; sporidia .0005 by .00025." In Saccardo, I., p. 729, it was listed, with a query, as *Amphisphæria*.

In the co-type in Herb. Peradeniya the perithecia are quite separate from one another, but crowded together on a slight basal layer of mycelium. They are conoid, 0.3 mm. diameter, apex papillate, pruinose, dark brown. The ostiolum is punctiform, and furnished with periphyses. The spores are elliptic to fusoid, ends obtuse, one-septate, not constricted, pale brown, with a striate, verrucose wall, $11-14 \times 5 \mu$.

The species is evidently *Phæonectria*, and will stand as *Phæonectria umbrinella* (B. & Br.).

204.—*Hypoxyton niphidium* B. & Br.

The original description of this species, in Fungi of Ceylon, 1067, is "Peritheciis prominulis in pulvinulos parvos aggregatis pulvere niveo conspersis; sporidiis cymbiformibus hyalinis three-septatis (No. 1089). On bark. Sporidia .001 long by .0003." In Saccardo it was included under *Melogramma*. Berlese, in *Icones Fungorum*, I., p. 50, stated that the original specimens were sterile.

The co-type in Herb. Peradeniya bears mature stromata. They are superficial, circular, up to 4 mm. diameter, pulvinate or flattened pulvinate, minutely tomentose, with prominent ostiola, and apparently pale yellow. The tissue of the stroma is rather loose and white. The perithecia are situated at varying depths and have thick yellow walls; the perithecial cavity is oval, about 0.35×0.25 mm., and the neck is up to 1.5 mm. long, totally immersed. The asci are 6-8 μ in diameter, with uniseriate spores. The spores are hyaline, fusoid, spinulose, three-septate, slightly constricted, ends apiculate or rounded, $30-34 \times 6-8 \mu$; sometimes one cell is inflated.

The structure of the stroma is that of *Hypocrea*. The spores resemble those of a *Hypomyces*, but are three-septate. The species agrees very well with *Broomella*, though the spores have only a short apiculus, not the long terminal filament figured by Broome for *Broomella Vitalbæ* (B. & Br.). It may therefore stand as *Broomella niphidium*. It is not, however, co-generic with *Broomella Ichneaspidis* Zimm.

205.—*Xylaria carpophila* Fr.

This species was recorded for Ceylon by Berkeley and Broome from Thwaites's 615 on the seeds of *Goniothalamus Hookeri* and on seeds of *Diospyros Ebenum*. The clavæ on *Goniothalamus Hookeri* are about 1 mm. in diameter, with a minute central core and a loose peripheral zone; they turn vivid purple with caustic potash, have long oval spores up to $8 \times 4 \mu$, and bear the typical basidia of *Penicilliopsis*. They are indistinguishable from *Penicilliopsis clavariæformis*, but are conidial only. As the latter species is recorded for *Diospyros* only, this conidial form may be a different species. The specimen of "*Xylaria carpophila*" on *Diospyros* is also *Penicilliopsis*.

206.—*Eutypa penes* (B. & Br.) Sacc.

This was described in *Fungi of Ceylon*, 1112, as "*Sphæria (Obvallatæ) penes* B. & Br. Cortici immersa; ostiolis minimis congestis, tandem emergentibus; ascis clavatis; sporidiis minimis allantoideis. On bark, which seems at first merely sprinkled with black spots." In Saccardo, I., p. 179, it was listed as *Eutypa*. Berlese (*Icones Fungorum*, III., p. 51) suggested that it might be *Eutypella*.

The ostiola are cylindric or subclavate, up to 0.5 mm. long and 0.1 mm. diameter. They burst through the epidermis in linear, oval, or circular clusters, up to 0.4 mm. long. The perithecia lie side by side beneath the epidermis; they are not united into a stroma, nor is there any black boundary line in the cortex; they are irregularly ovoid or globose, distorted by mutual pressure, about 0.25 mm. diameter, thin-walled, not carbonaceous. The asci are eight-spored, $12-16 \times 4-5 \mu$, with obliquely uniseriate spores. The spores are hyaline, subcylindric, ends obtuse, slightly curved, $4-5 \times 1.5 \mu$.

This species appears to be a *Calosphæria*, and will stand as *Calosphæria penes* (B. & Br.).

207.—*Amphisphæria megalospora* (Mont.) Sacc.

This species was recorded for Ceylon by Berkeley and Broome from Thw. 302. They described the spores as "brown, very obtuse, equal or larger above, uniseptate, .002 inches long."

In the part of Thwaites's 302 in Herb. Peradeniya the perithecia are scattered, or confluent in small groups, immersed in the cortex and splitting off the outer layers; they are about 1 mm. diameter, black, depresso-convex, with a flat base, about 0.5 mm. high, sparingly clothed at first with purple-brown mycelium, becoming naked, minutely rugose. The ostium is papillate, or slightly cylindric, circular, broad. The upper wall of the perithecium is thick, but not carbonaceous; the base is thin. The asci are thick-walled, eight-spored, about $240 \times 32 \mu$. Numerous linear, branched paraphyses are present. The ascospores are brown, then opaque, subcymbiform or reniform, with rounded ends, one-septate, constricted at the septum, the upper cell frequently larger than the lower, $37-40 \times 12-13 \mu$.

I am unable to refer to Montagne's figure. The spores agree fairly well with Currey's figure in Trans. Linn. Soc., XXII. (1858), tab. 49, fig. 192.

208.—*Leptosphaeria nesodes* (B. & Br.) Sacc.

Described by Berkeley and Broome in Fungi of Ceylon, 1121, as "*Sphaeria (Depazea) nesodes* B. & Br. Peritheciis minutissimis, in maculas pallidas congestis, fuscis; sporidiis fusiformibus curvulis triseptatis. On leaves of *Hydrocotyle asiatica*, Peradeniya, January, 1868. Sporidia .0005 (inches) long." It was listed as *Leptosphaeria* in Saccardo, II., p. 85. Berlese (Icones Fungorum, I., p. 88) stated that the specimens were not well developed, but were rather *Metasphaeria*. This opinion is supported by recently collected specimens, identical with the co-type in Herb. Peradeniya. The species will therefore stand as *Metasphaeria nesodes* (B. & Br.).

The perithecia are crowded on the under surface of brown, or blackish-brown, spots; they are globose, black, immersed, prominent, about 0.75 mm. diameter. The asci are broadly clavate, very shortly pedicellate, thick-walled at first, about $40 \times 10 \mu$. The ascospores are narrow subcymbiform, hyaline, ultimately three-septate, $15-20 \times 3-4 \mu$. The majority of the spores in the available specimens are uni-septate, the other two septa apparently being formed much

later than the median one. This is probably identical with *Stigmatea Hydrocotyles* Rac., on leaves of *Hydrocotyle* sp. from Java.

On the same plants occurs *Septoria nesodes* Kalch. The pycnidia of this species are chiefly hypophyllous; the spores are lanceolate, subacute, straight or curved, three- to five-septate, $34-50 \times 3.5-4 \mu$.

209.—*Cladosporium apicale* B. & Br.

Berkeley and Broome described this from the leaves of *Cycas circinalis* at Peradeniya; "floccis sparsis erectis sursum attenuatis, sporis apicalibus subfusiformibus. Forming transverse patches. Spores .0002-.0004 (inches) long." It occurs also on *Cycas Rumphii*.

The spots are pale brown, or brownish-white, with a purple-brown margin on the upper side; on the under side the margin is red-brown. They usually extend transversely from the margin to the midrib, and are consequently often rectangular. The conidiophores are hypophyllous, solitary or in small clusters, up to 0.2 mm. high, 5μ diameter, rigid, blackish-brown, unbranched, with an apical cluster of somewhat irregular basidia, which measure about $12 \times 5 \mu$. The conidia are catenulate, hyaline, then pale fuliginous, narrow-oval, ultimately one-septate, $5-8 \times 2-3 \mu$.

210.—*Graphium clavisorum* Berk.

This was recorded for Ceylon in Fungi of Ceylon, 902, on vine leaves, without locality or collection number. In Saccardo, Sylloge, IV., p. 631, this name is changed to *Isariopsis clavisporea* (B. & C.) Sacc. In the cover of *Isariopsis clavisporea* at Kew are Berkeley's specimens of *Graphium clavisorum* from Carolina, but no Ceylon specimen. The cover is marked by Massee "*Cercospora viticola* Ces." There is no Ceylon specimen in Herb. British Museum or Herb. Peradeniya.

211.—*Stilbum graphoideum* B. & Br.

This was described by Berkeley and Broome as "Nigrum, capitulo globoso basi in stipitem contracto; sporis minutis oblongis." No collection number was given. It was recorded

doubtfully by Cesati, collected by Beccari at Nuwara Eliya. The name was changed by Saccardo (Sylloge, IV., p. 614) to *Graphium obsoletum*. There are no specimens in Herb. Kew, British Museum, or Peradeniya.

212.—*Oidium simile* Berk.

Oidium simile was described by Berkeley in Hooker's London Journal of Botany (1845), p. 310, as "Effusa, submembranacea, fulva; hyphis ramosiusculis; articulis ultimis globosis." The type specimens were from Ohio. It was recorded from Ceylon in Fungi of Ceylon, 896, with the information that it occurred also in Ohio, Cuba, and the Nilgiris. In Saccardo it is listed as *Oospora similis*.

Ceylon specimens form effused, thin patches up to 4 cm. long and 3 cm. broad, or larger by confluence; they are orange, red-brown, or dark red-brown, with a fairly broad, white or yellowish, byssoid margin. The stroma is up to 0.3 mm. thick; its basal part is fairly compact, and consists of loosely interwoven hyphæ, 3-4 μ diameter; the upper free ends of the hyphæ bear the conidia, either terminally or on short lateral branches. The conidia are yellow-brown to dark brown, smooth, globose, 12-17 μ diameter, or pyriform, $20 \times 12-14 \mu$.

The Ceylon species is a *Hyphoderma*. It differs from Berkeley's figure and description of *Oidium simile*, and is evidently a different species. It may be known as *Hyphoderma zeylanica*.

***Hyphoderma zeylanica*.** Stroma effusum, ad 4 cm. long., 3 cm. lat., 0.3 mm. crass., aurantiacum, vel rufo-brunneum, margine albo vel flavescenti, byssoideo; hyphis 3-4 μ diam.; conidiis flavo-brunneis vel fusco-brunneis, levibus, globosis, 12-17 μ diam., vel pyriformibus, $20 \times 12-14 \mu$.

213.—*Mucor Artocarpi* B. & Br.

This is evidently identical with *Rhizopus Artocarpi* Rac., and will stand as *Rhizopus Artocarpi* (B. & Br.) Rac. Biological details of this species have been published by Sartory and Sydow in Annales Mycologici, XI., pp. 421-424, from specimens sent by C. F. Baker from the Philippines. It

occurs in abundance on the fallen flowers of *Artocarpus integrifolia*. In Ceylon morphologically identical species have been found on ripe plantains (bananas) and on drying copra (the "kernel" of the coconut).

214.—*Cyphella reticulata* B. & Br.

This was described by Berkeley and Broome in *Fungi of Ceylon*, 667, "*Pallida brevis erecta vel decumbens massam reticulatam polyporoideam simulans* (Nos. 265, 958). On dead wood."

Part of the type specimen is in Herb. Peradeniya, and fresh specimens have been collected. The individual cups are either peziziform, up to 0.2 mm. diameter, or tubular, up to 1 mm. high, 0.2 mm. diameter, or infundibuliform, up to 1 mm. high, 0.2 mm. diameter below, 0.8 mm. diameter above. The margin is inflexed at first. They are white, with a powdery outer layer, but pale yellow internally and beneath the powdery layer. In old weathered specimens and the old herbarium specimens the white layer has usually disappeared, and the cups are then yellow, and somewhat translucent. The basidia are clavate, about $15 \times 6 \mu$, and the spores hyaline, oval, $4-6 \times 3-4 \mu$. When growing close together, the cups coalesce, and form a *Poria*-like fructification, with irregular "pores," varying from 0.2 to 0.8 mm. in diameter.

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NOTES.

The Brazil-nut Tree in Ceylon.—When the notes published in Ann. Perad., V., pp. 421–431, were written, no fruits of the Brazil-nut tree at Henaratgoda were available. In 1915 this tree produced a single fruit, which ripened in 1916. The fruit was of the same type as those of the Peradeniya tree; the diameter of the operculum exceeded that of the opercular orifice, and consequently the operculum was retained within the ripe fruit. If this fruit character is considered of specific value, both the Ceylon trees must be referred to *Bertholletia nobilis*.—T. Petch.

The Pollination of the Bombax.—When the Bombax (*B. malabaricum* DC.) is in flower, even the casual observer cannot fail to notice the riotous congregations of crows which frequent the trees. One current explanation is that they feed on the flowers, but it can be clearly seen, with the aid of a field glass, that they are drinking from them. The fallen flowers do not bear any signs of having been bitten. The flowers, which stand, as a rule, more or less erect upon the branches, contain a comparatively large quantity of a bluish, somewhat opalescent liquid, and there seems no doubt that it is this which attracts the birds. They push their beaks down the middle of the flower, and, after withdrawal, perform the usual actions of drinking. To humans the liquid seems to lack any particular taste, but the more than ordinary talkativeness of the crows suggests interesting possibilities. It would appear probable that these birds are the chief agents in conveying pollen from one flower to another. Other smaller birds visit the flowers, but it is doubtful whether these could reach the nectar from the top of the flower; and as the style overtops the long clusters of stamens, it would not be touched by birds which inserted their beaks at the side. The crow which frequents the Bombax at Peradeniya is *Corone macro-rhyncha*.—T. Petch.

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